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ing for them gave a deficient or incorrect address. Any one who fails to receive within a reasonable time an answer to his request, or inquiry, should write again, as all communications which reach the Director receive prompt attention, and the Catalogue, or information desired, is forwarded at once.

THE MICHIGAN MINING SCHOOL: ITS PURPOSES AND HISTORY.

The Michigan Mining School was established as the fourth and last of the institutions of Michigan, which are devoted to higher education. From the moment of its inception its single object has been to send out men who are qualified to take an active part in the development of the mineral wealth of our State and Nation; and any subject of study which is essential to this end will not be found wanting in its courses of instruction.

The school has been singularly happy in its location. It is an axiom of modern education that any school, which is to obtain the greatest return for the money and energy spent in establishing it, must be situated in a region which shall from its very nature serve free of all expense, as a part of the real equipment of that school. This can be so only when the district presents for the daily observation of the student the most extensive and "up-to-date" practical applications of the subjects which are taught in the school, -a district in which the student is inspired with a strong appreciation of, and interest in, his future work, by being brought into frequent contact with able men whose lives have been devoted to the same profession. The location must be such that the body of the people regard the institution as a co-worker with them in the main business of their daily life, and naturally take far more interest in it, than in a school whose object and officials have little in common with them. The student thus lives in an atmosphere which harmonizes with his work and his attention and energies are not distracted and wasted by making digressions into matters which have no bearing on his real future.

On this account, medicine, law, theology and cognate subjects are best taught in large cities whose hospitals, libraries, courts, churches, societies, and meetings of congresses devoted to such subjects, all furnish material indispensable for the proper teaching of these branches of knowledge; mechanical and electrical engineering can be most advantageously studied only in a locality containing machine works, manufactures, mills, lighting and power plants; and civil engineering can be most thoroughly acquired in a school which has in its immediate vicinity numerous examples of modern constructions in the form of bridges, railways and their appurtenances, large buildings and establishments which design and produce the material for them. Similarly, mining engineering can be most efficiently taught only in a district containing numerous mines which are worked on the largest scale and in which scientific and economical considerations are given full sway.

From this point of view the Michigan Mining School has, more than any other school of mines in America, been fortunate in its location. Within a radius of eleven miles from its doors are situated several of the largest, deepest and most successful mines in the world. The most powerful and stupendous machinery ever employed in mining is here in constant use and always open to the inspection of the student. The aggregate horse power of the engines used by only two of these mining companies exceeds the grand total of all the engines used in the gold and silver mines in the United States in the halcyon days of 1889; or far more than double all those employed in the grandest spectacle this earth has ever seen—the World's Columbian Exposition in 1893.

The mines of the Marquette, Menominee and Gogebic iron ranges are within a few hours' ride of the school, and furnish a most efficient means of illustrating a large part of its teachings. The output of the various mines and other mineral industries in the Upper Peninsula is so enormous that its yearly value is about $70,000,000, and places Michigan, among the States of the Union, second only to Pennsylvania in the value of its mineral products.

The further development of this vast industry requires men who are thoroughly trained for this special work, and to meet this requirement the Michigan Mining School was established. It was fortunate for the School that its Founders realized at the start that, to fulfill its mission, it must not, as is so frequently and unfortunately done, waste its energies in the vain attempt to teach branches foreign to the object of the institution, and which were already well taught by other schools maintained by the State. In consequence they determined that this School should confine its attention wholly to *mining and the subjects relating thereto:* hence the course is designed to teach the student to conduct explorations in the forest and field; to distinguish the useful minerals and rocks; to understand the geological principles that govern the formation and association of useful mineral products, and to determine approximately their values; to study ores, building stones, limes, mortars, cements, coal, salt, gypsum, petroleum, natural gas, clays, fertilizers, gems, and useful vegetable products; to survey, map, and lay out the ground, the railroads, tramways, and towns; to select or design hoisting, transportation, power, and light plants; to design the mills, furnaces, docks, dams, bridges, shaft and rock houses, and other structures; to determine in each case which is the most suitable method for opening and conducting a quarry or mine, and of timbering, ventilating and draining it; to assay, concentrate and smelt ores; to investigate the strength and other properties of engineering materials, that designs may be intelligently worked out; to make working drawings to illustrate fully these designs; to understand the most economical methods of generating and using steam; to study in detail engines, pumps, boilers, and other machinery, and the methods of operating, testing and repairing them; to master the principles of electricity and its generation, storage, transmission, and use as an illuminant and source of motive power; to study hydraulics, and its various applications in civil affairs and hydraulic mining; to understand mine management and accounts; in short, to train men to be of real use in any line of work connected with the winning and reduction of mineral products.

Such work naturally arranges itself along various clearly defined lines in each of which the training may proceed to almost any length; hence the branches of study which here most naturally resolve themselves into specialties are drawing, chemistry, metallurgy, mechanical, civil, electrical and mining engineering, ore dressing and geology. In consequence, the men educated at the Mining School are now engaged as surveyors, mining, civil, electrical and mechanical engineers, woodsmen, explorers, railroad men, chemists, assayers, mill men, quarrymen, manufacturers, stock raisers, farmers, teachers, etc. It therefore appears that the Mining School has fulfilled its mission and educated its students to be useful and efficient men, who are daily adding to the world's material wealth and to its stock of knowledge.

The range of subjects bearing on the mineral industry is extremely wide; this, coupled with the fact that all men are endowed with a natural aptitude for some lines of work, while wholly unfitted for others; and the further fact that circumstances beyond control frequently force men into particular occupations and deprive them of the opportunity to prosecute a full course of training, all conspire to demonstrate the correctness of the modern educational view, that a rigid set course of instruction in higher education is now out of date, and that the student must have some liberty in selecting the studies which are to enable him to cope with his life work. This fact has been long recognized here, and the Mining School has squarely met the issue by adopting an elective system so designed that while the student is allowed to choose the main lines of his work, he is compelled by the *proper sequence* of studies to take up such subjects as are essential to a broad and thorough engineering training.

Further, in the effort to save the valuable time of young men, the school work is continued during forty-five weeks a year instead of thirty to thirty-six as in most institutions. This enables the student who so wishes, to accomplish as much in three years as he would ordinarily do elsewhere in four.

The instruction given at the Mining School is intended to be strictly professional and practical, and the school considers that to give a general educational training is as little in keeping with its legitimate functions as would be the case in schools devoted to law, medicine and theology. Such general training is already fully provided for by other institutions maintained by the State, and to attempt it here would cause a serious detriment in the quality of the engineering instruction, and add only a source of needless expense to the State. It is therefore clear that the Michigan Mining School in no way encroaches on the work which legitimately belongs to any other of our institutions of learning; indeed, it really assists them by offering an education which no one of them, by reason of its location, can possibly give in the way it is given here.

The mineral industries adjacent to the Mining School are the most efficient portions of its equipment. Without a similar advantage no school can properly teach mining, and any attempt to do so will result in an inferior engineering training, no matter if millions

of dollars be spent in equipping that school. The Pennsylvania Railway Company wisely recognized this principle when it established its school at Altoona. It wanted railroad men, and it very properly trains them at a place where all the matters pertaining to railways are directly under the eye of the student.

The Mining School forces its students to do thorough work, and also to acquire some practical knowledge of the subjects they are studying. The day has passed when engineering students could be properly trained through an equipment of lecture rooms, teachers and books; this school has therefore ever been mindful of the wise observation of Seneca: "Long is the way through precept, short and effective through examples," * hence it tries to make its students not only hear, but see, and to act with their own hands as well as their minds. In this fact and in it only, can be found the reason why its graduates have been signally successful in practice, and that they have rarely been attracted into a line of work different from that which they pursued at this School.

The Mining School was established by an act of the Legislature approved May 1st, 1885, and was opened for the reception of students on September 15th, 1886. Its inception, establishment, and to a great extent its appropriations have been due to the foresight, energy and executive ability of Hon. Jay A. Hubbell of Houghton. He has spared no labor in endeavoring to accomplish everything he considered essential to the success and prosperity of the institution.

In 1886, Albert Williams, Jr., a graduate of the College of New Jersey, was elected principal, and had charge of the school until he resigned during the summer of 1887. M. E. Wadsworth, a graduate of Bowdoin and post graduate of Harvard, was then chosen as Director, and still retains that position.

The first classes were taught in rooms located on the top floor and in the basement of the "fire engine house" of the village of Houghton. Four additional rooms in the Oddfellows Building were secured in September, 1887, but the continued growth of the school made it necessary to vacate the latter quarters during the summer of 1888, and to replace them by others obtained in the Roller Rink Building, now the Armory Opera House.

In May, 1889, the school was moved into the building now known as Science Hall. This was erected by the State on land donated men, who are daily adding to the world's material wealth and to its stock of knowledge.

---

* "*Longum est inter per præcepta, breve et efficax per exempla.*"

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In May, 1889, the school was moved into the building now known as Science Hall. This was erected by the State on land donated by Judge Hubbell, but even then it was well known that the building was too small for the necessary work of the school. In 1890, ore dressing works were constructed, and there was added in 1892 a small structure containing a furnace for roasting ores. As the school grew faster than its most sanguine friends had any reason to hope, further buildings became necessary, and during 1894-95 the State erected another large one to accommodate the departments of drawing and mechanical and electrical engineering, and the offices and lecture rooms of the department of civil and mining engineering.

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* "*Longum est inter per præcepta, breve et efficax per exempla.*"

The equipment of the institution has also been increased so far as its funds have permitted, and the total school property, as inventoried in August, 1895, amounted to $219,666.79.

In 1886, a course of instruction of two years duration was announced, but its details were not worked out; indeed, the educational side of the school was not regularly organized until the academic year, 1887-88. Since then the curriculum has been steadily broadened and perfected in detail. In 1889 a three years course was adopted, and in 1893 this was changed to four years. The full elective system went into successful operation in 1895, and has proven entirely satisfactory to both instructors and students alike.

No Mining School in America has ever had such a phenomenal growth as this one, whether viewed from the standpoint of attendance of students in mining engineering; in the thorough and practical nature of the education given; or in the standing the school has won at home and abroad. Since 1890 it has been recognized as one of the leading institutions of its kind in the world, and it will ever strive to retain this position by hard work and true merit, if those for whose benefit it was established will do their duty toward it.

The number of new students who entered; the total enrollment; and the number of graduates sent out for each year of the school's existence are as follows:

Year	'86-7.	'87 8.	'88-9.	'89-90.	'90-1.	'91-2.	'92-3.	'93-4.	'94-5.
New students.........	23	15	16	15	46	40	45	17	49
Total attendance.....	23	29	40	35	61	78	01	82	94
Graduates............	....	7	6	5	4	0	8	17	22=69

These students were from twenty-four different states of the Union and from the following foreign countries: Canada, Cuba, England, Germany, Japan, Mexico, New Brunswick, Peru and the South African Republic. The large majority of the students came from Michigan, as would naturally be expected from the magnitude of the mining interests of our state.

The Legislature has made for the school appropriations as follows:

	1885.	1887.	1889.	1891.	1893.	1895	Total.
Current expenses.......	$25,000	$17,500	$14,000	$57,600	$75,000	$80,000	$299,100
Building and Equipment .	....	75,000	60,000	15,000	35,000	....	185,000

Through the exercise of rigid economy in the use of its funds th institution has saved and put into equipment much of the money intended for current expenses, and so well has this been done that th average annual expense per student since the school was established has been somewhat less than $400 00. No other leading schoo has ever been able to do work of equal grade for so small a sum.

PROPERTY OF THE MICHIGAN MINING SCHOOL.

August, 1895.

MATHEMATICS AND PHYSICS.

Mathematics	$175 00	
Physics	7,580 22	
		$7,755 22

CHEMISTRY AND METALLURGY.

Qualitative Laboratory	$2,090 00	
Quantitative Laboratory	2,778 00	
Photographic Laboratory	532 95	
Assay Laboratory	2,319 91	
Metallurgy	1,242 00	
		$8,962 86

MECHANICAL AND ELECTRICAL ENGINEERING.

Drawing	$1,308 00	
Pattern Shop	1,858 00	
Machine Shop	6,433 10	
Testing Laboratory	3,657 00	
Steam Plant	2,910 00	
Electrical Engineering	3,641 00	
		$19,217 10

CIVIL AND MINING ENGINEERING.

Engineering Equipment	$6,646 15	
Ore Dressing Plant	3,461 57	
om t.		$10,107 72

MINERALOGY AND GEOLOGY.

Mineralogy	$8,373 50	
Petrography	7,523 88	
General Geology	3,630 10	
Economic Geology	823 00	
		$20,350 48
LIBRARY		23,465 06
ADMINISTRATIVE DEPARTMENT		426 75
SUPPLY ROOMS		6,231 78
BUILDINGS AND GROUNDS		123,159 82
Total		$219,666 79

BOARD OF CONTROL OF THE MINING SCHOOL.

1894—1896.

	Term Expires
James Renrick Cooper, Hancock	June 9, 1897
Preston Carpenter Firth West, Calumet	June 9, 1897
Hon. Jay Abel Hubbell, Houghton	June 9, 1899
Hon. Thomas Bree Dunstan, Hancock	June 9, 1899
Hon. John Monroe Longyear, Marquette	June 9, 1901
Alfred Kidder, Marquette	June 9, 1901

OFFICERS OF THE BOARD OF CONTROL.

PRESIDENT OF THE BOARD OF CONTROL,
HON. JAY ABEL HUBBELL.

DIRECTOR OF THE MINING SCHOOL,
MARSHMAN EDWARD WADSWORTH.

SECRETARY OF THE BOARD OF CONTROL,
ALLEN FORSYTH REES.

TREASURER AND PURCHASING AGENT OF THE MINING SCHOOL,
ALLEN FORSYTH REES.

OFFICERS OF THE MICHIGAN MINING SCHOOL.

1894–1895.

MARSHMAN EDWARD WADSWORTH, A. B., A. M. (Bowdoin College),
A. M., Ph. D. (Harvard University),
DIRECTOR,
Professor of Mineralogy, Petrography and Geology.

GEORGE AUGUSTUS KOENIG, M. E. (Polytechnikum, Karlsruhe),
A. M., Ph. D. (University of Heidelberg),
Professor of Chemistry and Metallurgy.

FREDERICK WILLIAM SPERR, E. M. (Ohio State University).
Professor of Civil and Mining Engineering.

EDGAR KIDWELL, A. B., A. M. (Georgetown University),
M. E. (University of Pennsylvania),
Professor of Mechanical and Electrical Engineering.

FRED WALTER MCNAIR, S. B., (University of Wisconsin),
Professor of Mathematics and Physics.

ARTHUR EDMUND SEAMAN,
Instructor in Mineralogy and Geology.

CARLTON FRANKLIN MOORE, E. M. (Michigan Mining School),
Instructor in Mechanical Engineering and Drawing.

MISS FRANCES HANNA,
Librarian and Secretary.

JAMES WILTON SHIELDS
Assistant in the Machine Shop.

GEORGE WASS,
Assistant in the Pattern Shop.

BURTON TYNDALL SEELEY, E. M. (Michigan Mining School)
Assistant in Chemistry.

FREDERICK PECK BURRALL, E. M. (Michigan Mining School),
Assistant in Chemistry.

ROBERT IRWIN REES,
Assistant in Physics.

LOUIS ALDRO WRIGHT,
Assistant in Mineralogy.

HENRY GIBBS,
Supply Clerk, and Janitor of Science Hall.

PATRICK ROBERT DILLON,
Engineer, and Janitor of Engineering Hall.

MISS KATE KILLIAN,
Stenographer and Typewriter.

JOHN BRIMACOMBE,
Janitor's Assistant.

OFFICERS OF THE MICHIGAN MINING SCHOOL.

1895—1896.

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Professor of Mathematics and Physics.

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Assistant Professor of Mineralogy and Geology.

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Instructor in the Pattern Shop.

BURTON TYNDALL SEELEY, E. M. (Michigan Mining School).
Assistant in Chemistry.

FREDERICK PECK BURRALL, E. M. (Michigan Mining School),
Assistant in Chemistry.

JAMES FISHER, E. M. (Michigan Mining School),
Assistant in Mathematics and Physics.

WILLIAM JOHN SUTTON,
Assistant in Mineralogy and Geology.

JOHN KNOX,
Assistant in Physics.

FREDERICK WALPOLE HOAR,
Assistant is Surveying and Mining.

GEORGE SLOCK, S. B. (Michigan Mining School,)
Assistant in Drawing.

HENRY GIBBS,
Supply Clerk, and Janitor of Science Hall.

PATRICK ROBERT DILLON,
Engineer, and Janitor of Engineering Hall.

MISS KATE KILLIAN,
Stenographer and Typewriter.

JOHN BRIMACOMBE,
Janitor's Assistant.

HERMANN RUMPH,
Engineer's Assistant.

FACULTY OF THE MINING SCHOOL.

Marshman Edward Wadsworth, A. M., Ph. D., Director,
Professor of Mineralogy, Petrography and Geology.

George Augustus Koenig, M. E., A. M., Ph. D.,
Professor of Chemistry and Metallurgy.

Frederick William Sperr, E. M.,
Professor of Civil and Mining Engineering.

Edgar Kidwell, A. M., M. E.,
Professor of Mechanical and Electrical Engineering.

Fred Walter McNair, S. B.,
Professor of Mathematics and Physics.

Arthur Edmund Seaman, S. B.,
Assistant Professor of Mineralogy and Geology.

Miss Frances Hanna, Librarian,
Secretary of the Faculty.

GRADUATES

OF THE

MICHIGAN MINING SCHOOL

AND THEIR

PAST AND PRESENT OCCUPATIONS.

NAME. OCCUPATION. PRESENT RESIDENCE.

REID, WILLIAM, S. B.,

Miner, Champion Mine, Beacon, Mich. Miner, Lake Superior Mine, Ishpeming, Mich. With R. J. Hosner, Romeo Door Hanger Co., Romeo, Mich. Conductor, West End St. Ry., Boston, Mass. Farmer, Lawtey, Florida. Clerk, Baltimore Dairy Lunch Co., Boston, Mass. *Boston, Mass.*

SEAGER, JAMES BENJAMIN, S. B.,

Mining Engineer and Chemist, Tyler's Forks Mine, Wis., and Excelsior Red Stone Co., Jacobsville, Mich. Superintendent of Excelsior Red Stone Co., Jacobsville, Mich. General Manager, Mackolite Fire Proofing Co., Chicago, Ill. *Chicago, Ill.*

UREN, WILLIAM JOHN, S. B.

Surveyor, Northern Michigan Railroad. Civil Engineer, Mineral Range and Hancock and Calumet Railroads. County Surveyor, Houghton County. Sub-Inspector, United States Engineers, Portage Lake Ship Canals. Draughtsman Lake Superior Iron Works, Hancock, Mich. *Hancock, Mich.*

1889.

CROZE, WALTER WILFRED JOSEPH, S. B.

Assistant Mining Engineer, Cleveland Mine, Ishpeming, Mich. Chief Mining Engineer, Jackson Iron Co., Negaunee, Mich. Mining Engineer, Houghton, Mich. Mining Engineer, Canton Mine, Biwabik, Minn. Superintendent of work on Magnolia Claim, Cripple Creek, Colo. Consulting Mining Engineer (Croze and Dengler), Denver, Colo. *Cripple Creek, Colo.*

FARWELL, PAUL, S. B.

Draughtsman, Colorado and Northwestern Railway, Pueblo, Colo. Assistant Chemist, Philadelphia Smelting and Refining Company, Pueblo, Colorado. Assistant Chemist, Anaconda Mining Company, Anaconda, Mont. Assayer and Chemist, Santa Rosa Consolidated Mining and Smelting Co., Musquiz, Coahuila, Mexico. Civil Engineer, Denver and Rio Grande Railroad. Assayer, A. M. Donaldson and Co., Denver, Colo. Assayer in charge, Assay Office of M. D. Currigan, Denver, Colo. *Denver, Colo.*

NAME. OCCUPATION. PRESENT RESIDENCE.

FESING, HERMAN WILLIAM, S. B., E. M. (1890).

Assistant City Engineer, Iron Mountain, Mich. Mining Engineer and Chemist, Hamilton Ore Co., Iron Mountain, Mich. Civil and Mining Engineer, Everett, Washington. Fee-Owner's Agent, Dunn, Crystal Falls and Columbia Mines, Crystal Falls, Mich. Chemist in charge of the Experimental Laboratory of John T. Jones, Iron Mountain, Mich. Assistant Superintendent, Manufacture and Introduction of Explosives, Summit, Ill. Mining Engineer, Dallas, Texas. *Dallas, Texas.*

HASS, JACOB, S. B., E. M. (1890).

Civil Engineer, Penokee and Gogebic Consolidated Mining Co., Ironwood, Mich. Assistant Mining Engineer, Cleveland and Iron Cliffs Mining Co., Ishpeming, Mich. Mining Engineer, Skylark Mines, Marcus, Washington. Mining Engineer and Assayer, Midway, B. C. Mining Engineer, Midway, B. C. *Midway, B. C.*

HOATSON, JOHN, S. B.

Assistant Mining Engineer and Chemist, Champion Mine, Beacon, Mich. Mining Captain, Silver Bow Mine, Silver Bow, Mont. Mining Engineer, Butte and Boston Mining Co. *Butte City, Mont.*

PRYOR, REGINALD CHAPPLE, S. B.

Assistant Civil Engineer, Isle Royale Land and Exploration Co., Isle Royale, Mich. Civil and Mining Engineer, Houghton. *Houghton, Mich.*

1890.

DANIELL, JOSHUA, S. B.

Assistant Mining Engineer, Tamarack, Osceola and Kearsarge Mines, Opechee, Mich. Assayer, Boston and Montana Consolidated Copper and Silver Mining Co., Great Falls, Mont. Blast Furnace Foreman, Boston and Montana Consolidated Copper and Silver Mining Co. *Great Falls, Mont.*

NAME. OCCUPATION. PRESENT RESIDENCE.

DRAKE, FRANK, S. B.

Assistant Mining Engineer, Chapin Mining Co., Iron Mountain, Mich. Mining Engineer, Buffalo Mining Co., Negaunee, Mich. Graduate Student, Michigan Mining School. Mining Engineer, Chapin Mining Co. Student, Massachusetts Institute of Technology, Boston, Mass. Mining Engineer, Taylor and Brunton, and H. P. Cowenhoven and Co., Aspen, Colo. Superintendent of the Russian-American Manufacturing Co.'s Mines in Russia. *St. Petersburg, Russia.*

HODGSON, WILLIAM ADAMS, S. B.

Manufacturer of General Cooperage, Stephens, Arkansas. Graduate Student, Michigan Mining School. *Houghton, Mich.*

SUTTON, LINTON BEACH, S. B.

Mining Engineer and Chemist, Volunteer Mine, Palmer, Mich. Chemist, Chapin Mining Co., Iron Mountain, Mich. Mining Engineer, Tremont Gold Mining and Milling Co., Gould, Montana. Mining Engineer and Chemist, Chapin Mining Co. *Iron Mountain, Mich.*

WAKEFIELD, ARTHUR ALBERT, S. B.

Mining Engineer, Fronteriza Silver Mining and Milling Co., Velardena, Mexico. Mining Engineer, Hurley, Wis. Mining Engineer, Velardena, Mexico. *Velardena, Durango, Mexico.*

1891.

BOSSERT, OTTO HENRY, E. M.

Student at the Bergakademie, Freiberg, Saxony. Assayor, Bingham Canyon, Utah. *Bingham Canyon, Utah.*

DENGLER, THEODORE, E. M.

Mining Engineer, Millie Iron Mine, Iron Mountain, Mich. Sub-Inspector, United States Engineers, Portage Lake Ship Canals, Houghton, Mich. Mining and Civil Engineer, Atlantic Mine, Mich. Consulting Mining Engineer (Croze and Dengler), Denver, Colo. *Denver, Colo.*

FINK, EDWARD, E. M.

Chemist and Metallurgist, with George W. Goetz and Co., Milwaukee, Wis. Organic and Technical Chemistry, Polytechnische Hochschule, Charlottenburg, Prussia. Chemist and Metallurgist with George W. Goetz and Co., Milwaukee, Wis. *Milwaukee, Wis.*

NAME. OCCUPATION. PRESENT RESIDENCE.

LAWTON, NATHAN OLIVER, S. B.
Chief Mining Engineer, the Penokee and Gogebic Development Co., Ironwood, Mich. Chief Mining Engineer and Chemist, Aurora Iron Mining Co., and City Engineer, Bessemer, Mich. *Bessemer, Mich.*

1893.

ABBOTT, A. ARTHUR, S. B., (Mich. Agricultural College), E. M.
Instructor in Drawing, Surveying, and Mechanical Engineering, Michigan Mining School. Draughtsman, S. E. Cleaves and Son, Hancock, Mich. Civil and Mining Engineer, Coulterville, Cal.
Coulterville, Mariposa Co., Cal.

CHURCH, GEORGE BATCHELOR, E. M.
Civil Engineer, Chicago, Ill. Miner, Comstock Silver Mine, Park City, Utah. Mining Engineer and Foreman, Comstock Silver Mine. Mining Engineer and Chemist, Daly West Mine, Park City, Utah. U. S. Deputy Surveyor. *Park City, Utah.*

FISHER, JAMES, E. M.
Instructor in Drawing, Y. M. C. A., Hancock, Mich. Assistant in Mathematics and Physics, Michigan Mining School. *Quincy Mine, Hancock, Mich.*

GILLIES, DONALD, E. M.
Assistant Assayer of the Parrot Mining and Smelting Co., Butte City, Mont. Assistant Assayer and Draughtsman, Montana Ore Purchasing Co., Butte City, Mont. Assayer, Lost River Mining Co., Cliffs, Custer Co., Idaho. Surveyor and Assistant Superintendent, W. A. Clark's Properties, Butte City, Mont. *Butte City, Montana.*

KIRK, MARCUS EUGENE, E. M.
Mining Engineer and Prospector, Aurania, Lumpkin Co., Georgia. Electrical Engineer, Missouri and Kansas Telephone Co., Kansas City, Mo. *Kansas City, Mo.*

MCDONALD, ERWIN HUNTINGTON, E. M.
Professor of Mining Engineering, College of Montana, Deer Lodge, Mont. U. S. Deputy Mineral Surveyor, Deer Lodge, Mont. Machinist, Anaconda Concentrator, Mont. *Anaconda, Mont.*

NAME. OCCUPATION. PRESENT RESIDENCE.

TRENGOVE, SAMUEL REED, E. M.

City Engineer, Red Jacket, Mich. Assayer, Tremont Gold Mining and Milling Co., Gould, Mont. Assayer, Diamond Hill Mining Co., St. Louis, Mont. Mining Engineer and Assayer, Office of Larsen and Greenough. *Millan, Idaho.*

WATERS, ALBERT LATCHA, S. B. (Mich. Agricultural College), E. M.

Superintendent Smelting and Concentrating Works, Blue Springs Mining Co., Blue Springs, Tenn. Assayer, Silver Creek Mining Co., Cooney, New Mexico. Night Stamp Mill Foreman, Silver Creek Mining Co. Assistant Mine Superintendent and Mining Engineer, Silver Creek Mining Co. Supply Clerk, Old Dominion Copper Mining and Smelting Co., Globe, Arizona. Timberman, Old Dominion Copper Mining and Smelting Co. *Globe, Arizona.*

1894.

BURRALL, FREDERICK PECK, E. M.

Topographer, Michigan Geological Survey, Houghton, Mich. Assistant in Chemistry, Michigan Mining School. *Houghton, Mich.*

COLWELL, ALFRED BUNDY, E. M.

Assistant Mining Engineer, Lake Angeline Mining Co., Ishpeming, Mich. Chemist, Buffalo Mining Co., Negaunee, Mich. Mining Engineer, Winthrop Iron Co., Ishpeming, Mich. Mining Engineer, Cripple Creek, Colo. Draughtsman, Surveyor General's Office, Denver, Colo. Superintendent, Goldfield Mining and Milling Co., Tin Cup, Colo. *Tin Cup, Colo.*

DURFEE, ELMER WHIPPLE, E. M.

Concentrating Mill, R. E. Lee Silver-Copper Mine, Lordsburg, New Mex. Superintendent, Concentrating Mill, R. E. Lee Silver-Copper Mine. *Lordsburg, New Mex.*

EBY, JOHN HENRY, E. M.

Civil Engineer and Draughtsman for Pennsylvania Traction Co., Lancaster, Pa. Draughtsman for Slaymaker and Henderson, Civil Engineers, Lancaster, Pa. Mining Engineer, Minnesota Mine of the Minnesota Iron Co., Soudan, Minn. *Soudan, Minn.*

HARRIS, HERBERT JEAN, S. B. (University of Wisconsin), E. M.

Engineer, Illinois and Mississippi Canal. Engineer Double Track Work, Madison Division, Chicago and Northwestern Railway. *Chicago, Ill.*

NAME. OCCUPATION. PRESENT RESIDENCE.

JONES, MAURICE LINDLEY, E. M.
Transit-man for Government Engineers, Eastern Division, Hennepin Canal, Bureau, Ill. Inspector, Illinois and Mississippi Canal. *Bureau, Ill.*

KIRCHEN, JOHN GEORGE, E. M.
Assistant Surveyor, Trap Rock River Railroad. Assistant Mining Engineer, Quincy Mine, Hancock, Mich. *Hancock, Mich.*

KNIGHT, JOHN ALEXANDER, E. M.
Chemist, Illinois Steel Company, Chicago, Ill. *9057 Commercial Avenue, Chicago, Ill.*

McDONALD, WILLIAM NEAL, E. M.
Practical Mining, National Mine, Ontonagon, Mich. Sub-Inspector, United States Engineers, Portage Lake Ship Canals, Houghton, Mich. Assistant Mining Engineer, Cleveland and Iron Cliffs Mining Co., Ishpeming, Mich. Assistant Surveyor, Isle Royale Co., Isle Royale, Mich. Assistant Surveyor, Atlantic and Salmon Trout River Railroad, Atlantic Mine, Mich. Assistant Surveyor, with J. P. Edwards, C. E., Houghton, Mich. Sub-Inspector, United States Engineers, Portage Lake Ship Canals. *Houghton, Mich.*

McFARLANE, GEORGE CAMPBELL, E. M.
Mining Engineer, Lemhi Mining Co. *Gibbonsville, Lemhi Co., Idaho.*

MASON, CLARENCE GEORGE, E. M.
Assistant Inspector, United States Engineers, Portage Lake Ship Canals. Chemist and Engineer, Jackson and Negaunee Mines, Negaunee, Mich. *Negaunee, Mich.*

MASON, RUSSELL TEAL, E. M.
Assistant in Physics, Michigan Mining School. Secretary of the University of Colorado, Boulder, Colo. Assistant in Mining and Surveying, Michigan Mining School. Assistant, Michigan Geological Survey, Houghton, Mich. *Houghton, Mich.*

MOORE, CARLTON FRANKLIN, E. M.
Assistant in Chemistry, Michigan Mining School. Instructor in Mechanical Engineering and Drawing, Michigan Mining School. *Houghton, Mich.*

NAME. OCCUPATION. PRESENT RESIDENCE.

Ridley, Frederick William, E. M.
Assistant Mining Engineer, Calumet and Hecla Mining Co., Calumet, Mich. Mechanical Engineer, in charge of Experimental Work, Calumet and Hecla Mining Co.
Lake Linden, Mich.

Rourke, Jerry, E. M.
Civil and Mining Engineer, Hancock, Mich. Civil Engineer, Cripple Creek, Colo. Mining Engineer, Michigan Gold Mining and Milling Co., Cripple Creek, Colo. Mining Engineer, Cripple Creek Gold Mining and Development Co. *Dubois, Colo.*

Seeley, Burton Tyndall, E. M.
Assistant in Chemistry, Michigan Mining School.
Houghton, Mich.

Wraith, William, E. M.
Resident Engineer for Canon City Coal Co., Rockvale, Colo. Engineer for Vulcan Fuel Co., at Newcastle, Colo. *Rockvale, Colo.*

1895.

Barlow, Royce Elwin, S. B., E. M.
Assistant Electrical Engineer, Chicago Traction Co.
No. 1239 Unity Building, Chicago, Ill.

Cameron, William McCallum, S. B., E. M.
Assistant Engineer, with Union Leasing and Mining Co., Leadville, Colo. Mining Engineer, Small Hopes Consolidated Mining Co., Leadville, Colo. *Leadville, Colo.*

Close, Fred Bagley, S. B.
Engineering Office, Hancock, Mich. Assistant in office of C. B. Davis, C. E., Chicago, Ill. Engineer, West Bluff Sewer System, Peoria, Ill. Assistant Chief Engineer of Calumet and Blue Island R. R., Chicago. Civil Engineer, Chicago Heights' Land Association, Chicago, Ill.
Chicago, Ill.

Coleman, Milton Watson, S. B., E. M.
Chemist, Ropes Gold and Silver Mining Co., Ishpeming, Mich. *Ishpeming, Mich.*

Dyer, Holmes Hayward, E. M.
Inspecting Engineer, Ishpeming Sewer System. Assistant Mining Engineer, Cleveland and Iron Cliffs Mining Co's., Ishpeming, Mich. Electrical Engineer and Superintendent of Public Works, Stanton, Mich. Assistant Mining Engineer, Cleveland and Iron Cliffs Mining Co.'s. Mining Engineer, Old Dominion Copper Mining and Smelting Co., Globe, Arizona. *Globe, Arizona.*

NAME. OCCUPATION. PRESENT RESIDENCE.

EMLAW, HARLAN STIGAND, S. B., E. M.
Draughtsman, Midland Terminal Railway, Cripple Creek, Colo. Transit man with U. S. Deputy Mineral Surveyor. *Cripple Creek, Colo.*

HOLBERT, HENRY HOFFMAN, S. B., E. M.
Mining Engineer, Low Moor Iron Co., Low Moor, Va. *Low Moor, Va.*

HONNOLD, WILLIAM LINCOLN, E. M.
Assistant Superintendent, Mahoning Ore Co., Hibbing, Minn. *Hibbing. Minn.*

MARTIN, NICHOLAS JOHN, S. B., E. M.
Oiler and Lighter, Drake and Stratton, Oliver Mine, Virginia, Minn. Conductor on Stripping Train, Oliver Mine. Time Keeper, Canton Mine, Biwabik, Minn. Assistant Engineer to City Engineer and to Engineer for Consolidated Mining Co. on Mesabi Range, Minn. *Virginia, Minn.*

McDONALD, RONALD H., S. B.
Assistant Surveyor, Quincy and Torch Lake R. R., Hancock, Mich. Assistant County Surveyor, Houghton County. Assayer and Chemist, Tamarack-Osceola Manufacturing Co., Dollar Bay, Mich. Chemist and Assayer, Lake Superior Smelting Co., Hancock, Mich. *Dollar Bay, Mich.*

MURRAY, ROBERT, JR., S. B., E. M.
Mining Engineer, Loretto Iron Co., Loretto, Mich. *Loretto, Mich.*

PALMER, EDWARD VOSE, E. M.
Transit-Man, Duluth, Mesabi and Northern R. R., Minn. Assistant Mining Engineer, Queen Iron Mining Co., Negaunee, Mich. Mining Engineer and Chemist, Queen Iron Mining Co. Secretary and Superintendent, Tenderfoot Hill Tunnel Gold Mining and Milling Co., Cripple Creek, Colo. *Cripple Creek, Colo.*

ORR, JOHN FORREST, S, B., E. M.
Mining Engineer, El Concheño, Mexico. *El Concheño, Mexico.*

ROPES, LEVERETT SMITH, S. B.
Explorer for Corundum, Messrs. Hamlin and Kline, Detroit, Mich. Mining Engineer, American Corundum, Co., Franklin, N. C. *Franklin. N. C.*

NAME.	OCCUPATION.	PRESENT RESIDENCE.
ROSE, ROBERT SELDEN, S. B.	Mining Engineer, El Concheño, Mexico. Assistant Engineer, D., S. S. and A. Railway, Superior, Wis. Supt. of Erection of Ore Docks, L. S. and I. Ry., Marquette, Mich.	*Marquette, Mich.*
SCOTT, DUNBAR DOOLITTLE, S. B	Assistant Cashier, Chapin Mine, Iron Mountain, Mich. Cashier and Mining Engineer, Millie Mine, Iron Mountain. Mining Engineer, Ludington Mine, Iron Mountain. Assistant Mining Engineer, Penokee and Gogebic Consolidated Mines, Bessemer, Mich. Material Agent, Metropolitan Iron and Land Co., Ironwood, Mich. Agent, Comet Mine, for Keweenaw Association, Limited, of Marquette, Bessemer, Mich. Chemist and Engineer, Montreal Mine, Hurley, Wis. Manager, Shores Mining Co., Iron Belt, Wis.	*Iron Belt, Wis.*
SEAMAN, ARTHUR EDMUND, S. B.	Assistant State Geologist, Michigan Geological Survey, Marquette, and Houghton, Mich. Assistant in Mineralogy and Geology, Michigan Mining School. Instructor in Mineralogy and Geology, Michigan Mining School. Assistant Professor of Mineralogy and Geology, Michigan Mining School.	*Houghton, Mich.*
SLOCK, GEORGE, S. B.	Assistant in Drawing, Michigan Mining School. Inspector, L. S. and I. Ry., Marquette, Mich.	*Houghton, Mich.*
STRINGHAM, JOSEPH, JR., S. B., E. M.	Examiner and Reporter of Gold Mines, Algoma District, Ontario, Canada. Bridge Builder on the Cleveland, Lorain and Wheeling R. R., Toledo Bridge Co., Toledo, Ohio. Mining Engineer, Cripple Creek, Colo.	*Cripple Creek, Colo.*
TOWER, LOUIS LOVELL, E. M.	Sub-Inspector on Dredge, United States Engineers, Grosse Point, Mich. Mining Engineer, Cook's Inlet, Alaska.	*Cook's Inlet, Alaska.*
UPHAM, WILLIAM ERASTUS, S. B., E. M.	Engineer and Chemist, Canton Iron Co., Biwabik, Minn. Engineer, Mining Department, Kansas City Smelting and Refining Co., Sierra Mojada, Coahuila, Mexico.	*Sierra Mojada, Coahuila, Mexico.*

NAME.	OCCUPATION.	PRESENT RESIDENCE.
WATSON, JOHN BONE, S. B., E. M.	Assistant Engineer and Chemist, Tamarack and Osceola Mines, Calumet, Mich.	*Opechee, Mich.*

PRESENT LOCATION OF GRADUATES.

STATES AND COUNTRIES.

Alaska	1
Arizona	3
British Columbia	1
California	1
Colorado	10
Idaho	2
Illinois	6
Massachusetts	1
Mexico	3
Michigan	22
Minnesota	3
Missouri	1
Montana	4
New Mexico	1
North Carolina	1
Russia	1
Texas	1
Utah	2
Virginia	2
West Virginia	1
Wisconsin	2
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REQUIREMENTS

FOR

ADMISSION.

REQUIREMENTS FOR ADMISSION.

1897-1898.

Students may enter in 1896, under the conditions published in the calalogue for 1892-1894, which will be sent on request.

Students who desire to enter as candidates for degrees, or to pursue special studies are admitted under the elective system through examination, exhibition of diploma, special certificate, or on presentation of evidence that they are prepared to follow with profit the special studies they elect. Detailed conditions for each of these cases are subjoined.

ADMISSION BY DIPLOMA.

A graduate of a high school or academy will be admitted upon presentation of his diploma, provided the school from which he received it, conforms to the following conditions: The school in question is to give a course of instruction, including all subjects embraced in the Mining School's requirements for admission through examination, in addition to such other studies as that school may consider it desirable for its students to follow. The principal or superintendent is to send to the Director of the Mining School a copy of the course of study, list of text-books employed, and copies of examination papers actually used in the school examinations. If these are satisfactory the school will, upon request, be placed upon the accredited or diploma list of the Michigan Mining School, which is hereafter to be published.

The authorities of all schools included in this list must send to the Director of the Mining School prompt notice of any subse quent changes of principals, superintendents or courses of study, otherwise their diplomas will not be accepted as fulfilling the requirements for entrance to this school.

If it shall subseqently be found that any student admitted upon the presentation of his diploma, was imperfectly prepared, he will excluded from the Mining School until his deficiencies are made up; and the school responsible for such deficiencies shall be stricken from the diploma list.

To indicate to the high schools the courses of study which the Mining School deems most advantageous, the following courses have been prepared:

COURSE OF STUDY, HIGH SCHOOL.

NINTH YEAR OR GRADE.

First Half Year.	English Composition and Literature, Arithmetic (Advanced and Commercial), Zoology, French.
Second Half Year.	English Composition and Literature, Physiology, Book-keeping and Business Law, French.

TENTH YEAR OR GRADE.

First Half Year.	Rhetoric, Algebra, General History, French.
Second Half Year.	Logic, Algebra, General History, French.

ELEVENTH YEAR OR GRADE.

First Half Year.	Civil Government, Geometry, Political Economy, German.
Second Half Year.	Botany, Geometry, Political Economy, German.

TWELFTH YEAR OR GRADE.

First Half Year.	Physics, Trigonometry, Physical Geography, German.
Second Half Year.	Physics, Astronomy, Physical Geography, German.

If it should be deemed more convenient for the school to mass its language work in the first two years, and the mathematics and science in the next two, the following course is recommended:

COURSE OF STUDY, HIGH SCHOOL.

(*Two Years Languages, Two Years Science and Mathematics.*)

NINTH YEAR OR GRADE.

First Half Year.	English Composition and Literature, Arithmetic (Advanced and Commercial), French, German.
Second Half Year.	English Composition and Literature, Civil Government, French, German.

TENTH YEAR OR GRADE.

First Half Year.	Physiology, General History, French, German.
Second Half Year.	Book-keeping and Business Law, General History, French, German.

ELEVENTH YEAR OR GRADE.

First Half Year.	Rhetoric, Algebra, Geometry, Zoology.
Second Half Year.	Logic, Algebra, Geometry, Botany.

TWELFTH YEAR OR GRADE.

First Half Year	Physics, Trigonometry, Physical Geography, Political Economy.
Second Half Year.	Physics, Astronomy, Physical Geography, Political Economy.

The courses of study just given are published simply to point out clearly the work which experience has demonstrated students should take before matriculating at the Mining School. That a student may be admitted to full standing the Mining School finds it essential to demand that he shall have a thorough knowledge of Arithmetic, Metric System, Book-keeping and Commercial Law, Algebra, Plane, Solid and Spherical Geometry, Physics, Astronomy and English Composition.

These branches excepted, it leaves to the judgment of the local school authorities the arrangement of the course and the selection of the studies to be taught in the school. It does not concern itself with the number or nature of these studies but asks how efficiently they are taught; it wishes to know if the student has gone *through* them instead of *over* them. Instruction in the common branches, including Arithmetic and United States History, is expected to precede the entrance to the high school. Any other languages, ancient or modern, except English, can be substituted for the French and German. It is, however, especially requested that instruction in Chemistry and Geology be entirely omitted when preparing pupils for the Michigan Mining School, as it is found that much better results are obtained if the student, previous to entering this school, devotes all his time to the other branches already enumerated.

If students are to achieve success here, it is imperative that they be able to collate facts, reduce them to order, draw sound conclusions from them, and use with facility the knowledge thus gained. All subjects of study, whether taught here or required for entrance, are regarded by the Mining School as merely so many tools which the student, in proportion to the excellence of his training, can use to advantage in shaping his future. The necessity for a daily drill in reasoning out fully, and applying through varied methods, the fundamental principles of each subject of study cannot be too strongly impressed upon teachers; without it no educational results of sterling value can be obtained. The Mining School has frequently found that its matriculates knew a little of everything, but very little of any one thing; they knew facts but no explanation of these facts. Their knowledge was almost valueless, because they lacked the training which could enable them to use it. These evils are not more common to graduates of high schools than of colleges and universities, and they demonstrate that the failure to teach men to *reason critically* is the chief defect of American education. Students are literally stuffed with facts gathered from all departments of knowledge, and by the time this heterogeneous mass has been swallowed no energy is left to digest it; hence but little development of the intellectual or reasoning faculties is possible, and the very object of all education is defeated. The Mining School considers such teaching a great evil, and urges all who are preparing students for it to see that fewer subjects than usual are taught, but that the instruction in them is such that memorizing is prevented, while the intellect is strengthened and sharpened by constant exercises.

The following text books will give a fair idea of the grade of work desired. In many cases, several books are recommended because conditions vary in different schools, and a work that is suitable for one institution is often ill adapted to the needs of another.

Other books in this list are named because they are considered to be the best works available for the use of those schools which, either through necessity or choice, have not introduced the modern laboratory method of instruction.

ALGEBRA.

Smith's Elementary Algebra, Irving Stringham.
Macmillan & Co., New York.

Hall and Knight's Elementary Algebra, or Algebra for Beginners, F. L. Sevenoak.
Macmillan & Co., New York.

School Algebra, College Algebra or Higher Algebra, G. A. Wentworth.
Ginn & Co., Boston.

Higher Algebra, George Lilley.
Silver, Burdett & Co., Boston.

Text Book of Algebra, Joseph V. Collins.
Albert, Scott & Co., Chicago.

School Algebra or University Algebra, Van Velzer and Slichter.
Tracy, Gibbs & Co., Madison, Wis.

Jones' Drill Book in Algebra, Geo. W. Jones.
Ithaca, New York.

ARITHMETIC.

Robinson's New Higher Arithmetic.
American Book Company, New York.

Smith's Arithmetic, C. L. Harrington.
Macmillan & Co., New York.

High School Arithmetic, Wentworth and Hill.
Ginn & Co., Boston.

ASTRONOMY.

Lessons in Astronomy, Charles A. Young.
Ginn & Co., Boston.

BOOK-KEEPING AND BUSINESS LAW.

Practical Business Book-Keeping, Manson Seavy.
D. C. Heath & Co., Boston.

Manual of Business Book-Keeping, A. L. Gilbert.
Albert, Scott & Co., Chicago.

Complete Practical Book-Keeping.
The Practical Text Book Co., Cleveland.

Business Law, Alonzo R. Weed.
D. C. Heath & Co., Boston.

BOTANY.

Introduction to Botany, Volney M. Spalding.
D. C. Heath & Co., Boston.

Lessons and Manual of Botany, Asa Gray.
American Book Company, New York.

CIVIL GOVERNMENT.

Civil Government in the United States, John Fiske.
Houghton, Mifflin & Co., Boston.

The American Civil Government, B. A. Hinsdale.
The Werner Co., Chicago.

The American Citizen, Charles F. Dole.
D. C. Heath & Co., Boston.

Young's Government Class Book, Salter S. Clark.
Maynard, Merrill & Co., New York.

Our Government, Jesse Macy.
Ginn & Co., Boston.

The Government of the United States, W. J. Cocker.
Harper & Brothers, New York.

The Government of the People of the United States; or A Course in Civil Government. Francis Newton Thorpe.
Eldridge & Brothers, Philadelphia.

CIVIL GOVERNMENT, MICHIGAN.

The Government of the People of the State of Michigan, Julia Anne King.
Eldridge & Brothers, Philadelphia.

Elements of Civil Government of the State of Michigan, Andrew C. McLaughlin.
Silver, Burdett & Co., Boston.

Civil Government of Michigan, H R. Pattengill.
Robert Smith, Lansing, Michigan.

CIVIL GOVERNMENT, BRITISH EMPIRE.

How We Are Governed, W. J. Gordon.
Frederick Warne & Co., New York.

COMPOSITION.

English Composition, Barrett Wendell.
Charles Scribner's Sons, New York.

Hand-Book of English Composition, J. M. Hart.
Eldridge & Brothers, Philadelphia.

Also see Rhetoric.

FRENCH.

French Grammar, A. P. Huguenet.
Hirschfield Brothers, New York.

French Grammar, A. Hjalmar Edgren.
D. C. Heath & Co., Boston.

Selected readings, particularly of "Scientific French,".

GEOMETRY.

Plane and Solid Geometry, VanVelzer and Shutts.
Tracy, Gibbs & Co., Madison, Wis.

Plane and Solid Geometry, Beman and Smith.
Ginn & Co., Boston.

Elements of Geometry, G. C. Edwards.
Macmillan & Co., New York.

Chauvenet's Geometry, W. E. Byerly.
J. B. Lippincott Co., Philadelphia.

White's Elements of Geometry, John Macnie.
American Book Company, New York.

GENERAL HISTORY.

General History, P. V. N. Myers.
Ginn & Co., Boston.

Studies in General History, Mary D. Sheldon.
D. C. Heath & Co., Boston.

GERMAN.

Eysenbach's German Grammar, William C. Collar.
Ginn & Co., Boston.

German Grammar, C. Brenkmann.
Hirschfield Brothers, New York.

Meissner's German Grammar, Edward S. Joynes.
D. C. Heath & Co., Boston.

German Science Reader, J. Howard Gore.
D. C. Heath & Co., Boston.

Course in Scientific German, H. B. Hodges.
D. C. Heath & Co., Boston.

HISTORY OF THE UNITED STATES.

History of the United States, John Fiske.
Houghton, Mifflin & Co., Boston.

American History, D. H. Montgomery.
Ginn & Co., Boston.

History of the United States, Allen C. Thomas.
D. C. Heath & Co., Boston.

The United States, Alexander Johnston.
Charles Scribner's Sons, New York.

LITERATURE.

Masterpieces of British Literature.
Houghton, Mifflin & Co., Boston.

Masterpieces of American Literature.
Houghton, Mifflin & Co., Boston.

A Century of American Literature, Huntington Smith.
Thomas Y. Crowell & Co., New York.

Introduction to English Literature, F. V. N. Painter.
Leach, Shewell & Sanborn, Boston.

Essential Studies in English and American Literature, James Baldwin.
John E. Potter & Co., Philadelphia.

A Hand Book of Literature, Esther J. Tremble.
Eldridge & Brother, Philadelphia.

Studies in English and American Literature, Albert N. Raub.
Raub & Co., Philadelphia.

LOGIC.

The Principles of Science, W. Stanley Jevons.
Macmillan & Co., New York.

Elementary Lessons in Logic, W. Stanley Jevons.
Macmillan & Co., New York.

Logic, Inductive and Deductive, William Minto.
Charles Scribner's Sons, New York.

Logic and Ontology, or General Metaphysics, Walter S. Hill.
John Murphy & Co., Baltimore.

PHYSICAL GEOGRAPHY.

Elementary Physical Geography, Ralph S. Tarr.
Macmillan & Co., New York.

The Realm of Nature, Hugh Robert Mill.
Charles Scribner's Sons, New York.

The Elements of Physical Geography, Edwin J. Houston.
Eldridge & Brothers, Philadelphia.

Complete Geography, Alex. Everett Frye.
Ginn & Co., Boston.

Maury's Physical Geography, Mytton Maury.
University Publishing Co., New York·

PHYSICS.

A Text Book of Physics, Hall and Bergen.
Henry Holt & Co., New York.

Principles of Physics, or, Introduction to Physical Science, A. P., Gage.
Ginn & Co., Boston.

Elements of Physics, Carhart and Chute.
Allyn & Bacon, Boston.

Physical Laboratory Manual, H. N. Chute.
D. C. Heath & Co., Boston.

Elements of Physics, S. P. Meads.
Silver, Burdett & Co., Boston.

Physics by Experiment, Edward R. Shaw.
Maynard, Merrill & Co., New York.

PHYSIOLOGY.

The Essentials of Health, Charles H. Stowell.
Silver, Burdett and Co., Boston.

Physiology for Beginners, Foster & Shore.
Macmillan & Co., New York.

An Academic Physiology and Hygiene, Brands and Gieson.
Leach, Shewell & Sanborn, Boston.

Comprehensive Physiology, John C. Cutter.
J. B. Lippincott Co., Philadelphia.

Physiology and Hygiene, Joseph C. Hutchinson.
Maynard, Merrill & Co., New York.

Human Physiology, John Thornton.
Longmans, Green & Co., New York.

POLITICAL ECONOMY.

Outlines of Economics, Richard T. Ely.
Hunt & Eaton, New York.

Political Economy for Beginners, Millicent Garrett Fawcett.
Macmillan & Co., New York.

Political Economy for American Youth, Jacob Harris Paton.
A. Lovell & Co., New York.

RHETORIC.

Foundations of Rhetoric, A. S. Hill, with Practical Exercises in English, Huber Gray Buehler.
Harper & Brothers, New York.

A Text-Book on Rhetoric, Brainard Kellogg.
Maynard, Merrill & Co., New York.

Elementary Composition and Rhetoric, William Edward Mead.
Leach, Shewell & Sanborn, Boston.

Composition and Rhetoric, William Williams.
D. C. Heath & Co., Boston.

Practical Rhetoric and Composition, Albert N. Raub.
Raub & Co., Philadelphia.

Exercises in Rhetoric and Composition, G. R. Carpenter.
Macmillan & Co., New York.

TRIGONOMETRY.

Plane Trigonometry, S. L. Loney.
Macmillan & Co., New York.

Elementary Trigonometry, Hall and Knight.
Macmillan & Co., New York.

Plane and Spherical Trigonometry, H. N. Wheeler.
Ginn & Co., Boston.

Elements of Trigonometry, Edwin S. Crawley.
J. B. Lippincott & Co , Philadelphia.

Orton's Comparative Zoology, Charles Wright Dodge.
Harper & Brothers, New York.

Introduction to the Study of Zoology, B. Lindsay.
Macmillan & Co., New York.

METHODS OF INSTRUCTION.

Since experience shows that certain methods of instruction yield better results than others, and that a practical education demands a much more intimate acquaintance with some parts of subjects than with others, some suggestions regarding the teaching of many high school studies are here given.

ASTRONOMY.

Preparatory work in Astronomy is desired for two purposes. One: For use in Surveying and other engineering work. Two: As a rational foundation for a philosophical treatment of geological problems.

The pupils should be thoroughly prepared in all subjects given in Young's Lessons in Astronomy, paying particular attention to those studied in chapters I., III., IV., V., VI., VII., VIII., IX., X., XI., XII , and XIV.

BOOKKEEPING AND BUSINESS LAW.

The pupil should master the principles of single and double entry, business forms, the laws of contracts, and such general principles as he must use in everyday life, in mine accounts, drawing up specifications, letting engineering contracts, etc. The foundation laid in the high school should be so broad and deep that an ample structure can be built upon it during some of the subsequent studies in the Mining School.

BOTANY.

In Botany it is desired that the instruction shall cover the classification of plants, as a preparation for the subsequent study of Economic Botany and Palæontology.

The student should also be made acquainted with as many as practicable of the useful trees and other plants growing in the locality where he is making his studies.

CIVIL GOVERNMENT.

In this subject the pupil should be thoroughly taught the principles which underlie our municipal, state and national governments, and his duties and rights as a law-abiding citizen. The principles of government are desired, rather than special details of their construction in laws and constitutions.

ENGLISH LITERATURE, COMPOSITION AND RHETORIC.

The student's success in meeting the ever increasing competition of our modern civilization demands of him an ability not only to produce ideas, but to state them briefly, forcibly and clearly; teachers are therefore urged to give special attention to the above named subjects.

Through literature the pupil should gather a knowledge of the methods of expression employed by the best writers; the training in composition and rhetoric should then be conducted with a view of making him proficient in applying these methods, when discussing, either orally or in writing, the things that play a part in his daily life. On no account should the pupil have as a subject for an exercise anything, concerning which he lacks either knowledge or interest, since such an exercise only wastes his time, and cultivates in him a forced and unnatural literary style.

FRENCH AND GERMAN.

It is particularly desired that the instruction in these subjects should look entirely to teaching the student to read the language, instead of speaking it; when practicable the reading of scientific texts should form an integral part of his course.

LOGIC.

It is not necessary that the pupil follow a formal course in logic, but he must be so taught as to be able to perceive whether a given conclusion correctly follows from the premises supplied. He must know the nature of a syllogism, even though he has never heard the name of it. The teacher can easily select from Jevons' Principles of Science, edition of 1892, such parts as are adapted to his needs.

MATHEMATICS.

Efficient teaching of geometry requires of the instructor more patience and skill than does any other mathematical subject of a high school course, hence it is in this subject that candidates for entrance are found most deficient. It is therefore necessary to reiterate that the prime object of a course in geometry is not to furnish the student with facts, but to quicken his intellect, and train him to think rapidly and logically. The acquisition of facts will then follow as a natural consequence. The teacher is advised to lay out a short course embracing the facts essential to the student's future studies, and select such text-books and class room methods that the pupil shall be unable to memorize any demonstration.

During the preparation in Algebra special stress should be laid on Factoring, Fractions, Quadratic Equations, Radicals, and Indices. The course in Trigonometry, to be satisfactory, must be based on the ratio system; particular attention should be given to solution of trigonometric equations, transformation of trigonometric expressions, solution of triangles, and the theory and use of logarithms, excluding their *computation.*

PHYSICAL GEOGRAPHY.

Physical Geography should be taught in connection with, or after, Physics; and not, as is so commonly done, in the more elementary portions of the high school course, otherwise the pupil cannot acquire the broad and comprehensive knowledge of the subject which is here desired. If properly taught, Physical Geography can and ought to replace the Geology given in many of the high schools.

Tarr's Physical Geography shows well the ground that should be covered.

PHYSICS.

Much has been said of the necessity of teaching Physics by the "laboratory method"; while it is generally admitted that this method is the only logical and thoroughly efficient one, its agitation has led some teachers to gather the impression that simply because a student is manipulating apparatus in conformity with some set instructions, he is in consequence learning Physics. Such ideas are wholly erroneous; mere motions of the hands without corresponding exercise of the thinking faculties can no more produce intellectual fruit in a laboratory than in a corn field. If the course is to be of value, the student must be compelled to record every experiment whether made by the teacher or by himself, in a neatly written and systematically arranged report covering the objects of the experiment, apparatus employed, methods of procedure with reasons therefor, the observations made, the computations together with all the figuring, and conclude with a succinct statement of the laws verified, or quantities determined.

No matter how limited the facilities at his command, every teacher is urged to require *some* laboratory work of his students. There are numerous laboratory manuals abounding in suggestions which will help the inexperienced to gain much valuable knowledge through the thoughtful use of material in the possession of every home.

PHYSIOLOGY.

In connection with this subject, it is desired that special stress be laid on a full discussion of the laws of health, habits of personal neatness and order, the use, and the abuse of narcotics and stimulants, since high school graduates appear, as a rule, to have but little knowledge of these and other such subjects which have so great a bearing on their future well being.

POLITICAL ECONOMY.

As the students of the Michigan Mining School are educated for the purpose of becoming active producers in increasing the wealth of the country, it is considered highly important that they should be instructed in the principles and laws of production, exchange, distribution, and consumption of valuable materials, and the relations of governments thereto; while special attention should be given to questions pertaining to the employé, the employer, and finance.

ZOOLOGY.

In Zoology, special attention should be paid to the classification and relationships of animals, in order to prepare properly the pupil for his subsequent work in Paleontology and Stratigraphical Geology.

In conformity with the general policy of the Mining School to give every aid and support it can to the cause of education in the public schools, its instructors will be pleased to afford help to teachers who desire it, in arranging their courses, or in assisting them through the free use of the school's laboratories, apparatus and collections.

ADMISSION BY CERTIFICATE.

In many cases young men have engaged in mining operations or in other business until they have arrived at the age of 18 to 25 years, when they desire to better their condition by obtaining an education that will be of practical benefit to them; but are not able to spend the time necessary to graduate in the usual high school course. Such men prove to be among the best of students, since they realize the necessity of an education and the value of time. In order to help them and at the same time to benefit the high schools, (since otherwise these pupils would never return to them), the Mining School will admit from the high schools persons who are 19 years of age or over, upon the presentation of a certificate from the high school superintendent or principal, certifying that the pupil has satisfactorily completed a two year's course in his school, provided this course shall be the equivalent of the one given below. If any of these students are subsequently found to be not qualified they will be dropped from the Mining School and the names of the schools which sent them be stricken from the approved list.

TWO YEARS HIGH SCHOOL, PREPARATORY.

(*Pupils, Nineteen Years of Age or Over.*)

FIRST YEAR.

First Half Year.	English Composition and Literature, Arithmetic and the Metric System, Algebra, Geometry.
Second Half Year.	English Composition and Literature, Bookkeeping and Commercial Law, Algebra, Geometry.

SECOND YEAR.

First Half Year.	Physics, Physical Geography, Botany and Zoology, Political Economy.
Second Half Year.	Physics, Physical Geography, Astronomy, Political Economy.

ADMISSION BY EXAMINATION.

All students who desire to enter the regular undergraduate work of the Mining School by examination, must pass in the following subjects:

ENGLISH COMPOSITION.—The candidate will be required to write upon some subject selected from Physics or Astronomy.

ARITHMETIC AND METRIC SYSTEM.

BOOKKEEPING AND COMMERCIAL LAW.

ALGEBRA, THROUGH QUADRATIC EQUATIONS.

GEOMETRY—PLANE, SOLID AND SPHERICAL.

PHYSICS.

ELEMENTS OF ASTRONOMY.

Conditions in Book-keeping and Astronomy are allowed when necessary, owing to the fact that many of the high schools do not give instruction in these subjects. The condition in Astronomy must be made up at the commencement of the winter term after entrance, and the condition in Book-keeping by the commencement of the fall term of the year after entrance.

For text-books to be used in this preparation, see the list given on preceding pages.

SPECIAL STUDENTS.

Persons of suitable age will be admitted without examination as special students to take such studies as they may be found qualified to pursue.

Since its organization the Mining School has had many students of ages* varying up to nearly 60 years enter for special work. They do not ask to receive a degree, but desire to study certain subjects which they consider will be useful in their subsequent work. Such students have proved themselves excellent and valuable workers, and the Mining School extends a most cordial welcome to all such and will give them every advantage that lies in its power. It has aided in this way numerous practical and active business men who have had many years of previous experience, and it is desirous of continuing a work from which such valuable results have been obtained in the past—a work which it will ever take pride in doing.

The Michigan Mining School especially desires to aid those who in their younger days have not had the opportunity of obtaining the higher education that their subsequent work demands, since it is well known at this school that the zeal and experience of such men more than overbalance the defects in their early training.

PREPARATORY STUDIES IN THE MINING SCHOOL.

Since its organization the Michigan Mining School has has spared no labor to aid the high schools to hold their students until they had graduated. Circumstances beyond its control compelled the Mining School in 1895–96 to temporarily and reluctantly take up part of the preparatory work in Algebra, Geometry, Book-keeping, Physics and Astronomy.

Since then arrangements have been perfected with the Houghton High School whereby every facility practicable will be given in that institution to pupils desiring to prepare for the Mining School. Should this plan prove satisfactory in 1896-97, the Mining School intends to abandon all its preparatory work after the opening of the summer of 1897, and all pupils desiring to take such work will be turned over to the Houghton and such other high schools as make satisfactory arrangements.

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* The average age is from 24 to 39 years.

Details have so far been perfected that hereafter the diplomas and certificates of the Houghton, Calumet and Lake Linden high schools will enable their possessors to enter the Michigan Mining School without examination.

COURSES

OF

INSTRUCTION.

COURSES OF INSTRUCTION.

The Michigan Mining School has been the first technical school in the United States to adopt a full and free elective system for its engineering instruction.

Concerning the elective system, it may be said that in this country two systems have been chiefly followed in the higher educational institutions—the fixed and the elective. The latter was introduced first in this country by President Wayland, of Brown University, and it has since been systematized and developed with remarkable skill and success by President Eliot, of Harvard. Indeed, the system has proved to be so well adapted to the needs of modern times and to be so popular that it has made its way in the face of strenuous opposition, until all or nearly all of our colleges and universities have employed it for their work in general or literary, and scientific education.

In technical or engineering education the case has been different, since even those schools which have a most liberal elective system for general education, have still only a partially modified form of the rigid system in the engineering or technical courses. The rigid system is disguised in most institutions in their technical work under the head of election between various fixed courses, which may or may not have a few options, or it masquerades under an elective dress to which it has but little, if any, right.

The elective system, proper, in any of the higher institutions, giving general education, consists of two features: First, the Essential Studies; second, the Sequence of Studies. The first is composed of those studies which are considered in each institution as necessary, or essential to maintain the scholarship or traditions of the school in question, and in engineering schools, the required and essential studies as a rule constitute the chief amount of the entire course in any of the engineering branches. In the case of general or literary education, the number of studies that are considered essential usually rapidly diminishes according to the experience and number of the Faculty, until only a few studies are required; and in time this feature will be fully eliminated.

Regarding the second, or "Sequence of Studies," but little public attention is called to it in any statements relating to electives in any institution, although it is the keynote of them all. No school can maintain any elective system or any work above a kindergarten or primary grade, without carefully considering the question of the natural sequences. It is the unwritten law, that no student can take Calculus who has not previously prepared himself in Algebra, nor can he study Petrography without any knowledge of Mineralogy.

Hence, on account of the natural sequence of studies, every instructor in the Mining School not only has the right, but also is obliged, to demand that each student, before being admitted into his class, must have completed every preparatory subject essential to the work of that class. This is a necessary and fundamental part of the elective system.

The Michigan Mining School's province is to train men to assist in the development of the mineral wealth of the country. To do this it has attempted to apply to technical or engineering education the same methods that are used in the elective systems of the various higher literary and scientific institutions of the country. In accomplishing this, it has tried to reduce to a minimum all studies to be taken by every student, to conserve the sequence, and to obtain thorough work by the business method of individual responsibility.

The only studies required of all the students are the "Elementary Principles of Geology" and the "Elementary Principles of Mining"—these are asked for because it is believed that in any institution dealing with the problems relating to the mineral wealth of the country, the student should have some knowledge of Geology and of mining methods, and also because the Director desires to come into personal contact with every student in the school, early in his course. The above mentioned studies require, altogether, the student's presence in the class room only three times a week for twenty-eight weeks.

Outside of the Elementary Geology and Mining the student is allowed unrestricted freedom of choice in his studies, the same as he is in the literary, but not in engineering, work in any other of our colleges or universities; observing, of course, the proper sequences.

In the elective system of the Michigan Mining School, the unit of work is taken as three hours a week in the class room or nine hours a week in the laboratory for thirty-four weeks, and this amount of work is called a course or a full course, while any subject scheduled for less time is taken for its proportionate part of a full course. The student, to obtain the degree of Bachelor of Science, must complete eighteen full courses, and to obtain that of Mining Engineer, twenty-two full courses, which in both cases include the subjects of Elementary Geology and Mining.

Owing to the fact that the regular work in the Michigan State Mining School extends through forty-five weeks of the year, a good student can obtain his degree in three or in four years, depending upon the question of whether he remains during the forty-five weeks each year, or for only the first thirty-four weeks; and, also, whether he wishes his course to be largely of practical or of theoretical work.

CHOICE OF ELECTIVES.

Duplicate written lists of the electives chosen for each year are to be handed to the Secretary by every student intending to remain during the subsequent year, by the Saturday before the preceding commencement.

Students joining the school at the beginning of, or during the year are to present at the time of entrance their choice of electives for the year in which they enter.

The full courses can be made up of studies which form a complete subject, *i. e.*, any subject numbered in the list of electives, but no partially completed or broken study will be accepted for any part of a full course or receive any credit.

Table I. shows the time in the year that each subject is taught, commencing with the opening of the school year, about the middle of September, and numbering the weeks around to September again. The number of hours given shows the time expected to be taken by the student in the class room, laboratory, etc., but does not include the time needed to be spent in preparation for the exercise.

Tables II. and III give the days of the week and the hours of the day that the student is to set apart for meeting the instructor in the class or lecture room.

In selecting his electives the three tables should be used together, in order to prevent a conflict owing to two subjects elected coming at the same hours and weeks.

Certain subjects consuming a large amount of time for laboratory work have been scheduled at more than nine hours a week but are not necessarily rated in the courses in proportion to the hours taken.

After the electives have been chosen for the year, a student can change, drop or take up any study only in the following manner: He is to hand to the Secretary a written request addressed to the Director, stating the change desired and the reasons therefor. This petition before it is placed in the Secretary's hands is to bear the written approval of each and every instructor affected by the proposed change. If it shall then be approved by the Director the change may be made, and the Secretary shall so inform the instructors and student interested. Further, the work already done in the elective from which the change is made, will not be counted, but the student will be obliged to complete the required work in the subject to which he is transferred, as if the latter subject had been originally chosen.

Any student failing to hand in to the Secretary his choice of studies by the time specified, or who drops or takes up any study, except in the manner here stated, will be considered as having withdrawn from the school, and will stand suspended from all exercises in the institution until he is reinstated by the Director.

If at any time the Director shall consider that any student is taking too few studies to properly occupy his time, he may require that student to take additional subjects; again, if the student has elected more work than he can properly perform the Director may require him to drop such studies as may be thought best.

Since the majority of the electives require other studies to precede them as preparatory work, the student when making his choice of studies must be guided by the sequence as given in the list of electives. In very exceptional cases a student may be allowed by the Director with the approval of the instructor concerned, to take a subject out of its order, but when the work is so taken, no credit will be given for it, until the required preparatory work has been fully made up.

Each instructor is the sole judge of the fitness of every student electing his subjects; he may refuse to admit into his class any student found deficient in preparation, or dismiss from his courses at any time a student whose work is unsatisfactory.

OUTLINE

LIST OF

THE COURSES OF

INSTRUCTION.

A. MATHEMATICS.

PROFESSOR McNAIR AMD MR. FISHER.

A 1. ALGEBRA. Three times a week, thirty-four weeks. To count for a full course. Mr. Fisher.

A 2. PLANE TRIGONOMETRY. Three times a week, fourteen weeks. To count as a two-fifths course. To be preceded by or accompanied with subject A 1 (Algebra). Mr. Fisher.

A 3. SPHERICAL TRIGONOMETRY. Four times a week, six weeks. To count as a one-fifth course. To be preceded by subject A 2 (Plane Trigonometry). Mr. Fisher.

A 4. ANALYTIC GEOMETRY. Four times a week, twenty weeks. To count as a four-fifths course. To be preceded by subject A 2 (Plane Trigonometry). Mr. Fisher.

A 5. DIFFERENTIAL AND INTEGRAL CALCULUS. Four times a week, twenty-eight weeks. To count as a full course. To be preceded by subjects A 1 (Algebra), A 2 (Plane Trigonometry), and A 4 (Analytic Geometry). Professor McNair.

A 6. INTRODUCTION TO DIFFERENTIAL EQUATIONS. Four times a week, six weeks. To count as a one-fifth course. To be preceded by subjects A 5 (Calculus) and C 1 (Analytic Mechanics). Professor McNair.

B. PHYSICS.

PROFESSOR McNAIR AND MR. KNOX.

B 1. PHYSICS. Twelve hours a week, thirty-four weeks. To count for a full course. Must be preceded by, or accompanied with, subjects A 1 (Algebra), and A 2 (Plane Trigonometry). Professor McNair and Mr. Knox.

B 2. PHYSICAL MEASUREMENTS. Twelve hours a week, six weeks. To count as a one-fifth course. Must be preceded by subject B 1 (Physics).

Professor McNair and Mr. Knox.

B 3. ELECTRICAL MEASUREMENTS. Three times a week, thirty-four weeks. To count as a full course. To be preceded by subjects B 1 (Physics) and C 1 (Analytic Mechanics).

Professor McNair.

C. MECHANICS.

PROFESSOR McNAIR.

C 1. ANALYTIC MECHANICS. Three times a week, fourteen weeks. To count as a two-fifths course. To be preceded by, subject B 1 (Physics), and preceded by, or accompanied with, subject A 5 (Calculus). Professor McNair.

C 2. ANALYTIC MECHANICS. Three times a week, fourteen weeks. To count as a two-fifths course. To be preceded by subject C 1 (Analytic Mechanics).

Professor McNair.

F. CHEMISTRY.

PROFESSOR KOENIG AND MR. BURRALL.

F 1. GENERAL EXPERIMENTAL CHEMISTRY. Nine hours a week, twenty-eight weeks. To count as a four-fifths course.

Professor Koenig and Mr. Burrall.

F 2. BLOWPIPE ANALYSIS. Twelve hours a week, six weeks. To count as a one-fifth course. To be preceded by subject F 1 (General Experimental Chemistry).

Professor Koenig and Mr. Burrall.

F 3. QUALITATIVE ANALYSIS. Nine hours a week, twenty eight weeks. To count as a four-fifths course. To be preceded by subjects F 1 (General Experimental Chemistry) and F 2 (Blowpipe Analysis).

Professor Koenig and Mr. Burrall.

F 4. QUANTITATIVE ANALYSIS. Twelve hours a week,

Winter Tern

THURSDAY.

Calculus.
Electrical Engineeri
Principles of Mining
Elementary Algebra

Plane Trignometry.
Analytic Geometry.
Mechanical Enginee

Qualitative Analysi
Electricity and Mag
Elementary Physics

Algebra
Quantitative Analy
Mine Ventilation.

Metallurgy.
Machine Design.
Geometry.

Mechanical Drawin
Petrography.

Topographical Dra
Economic Geology.
Book-keeping.
Astronomy.

Electrical Enginee
Mine Management.
Economic Botany.

Principles of Geol
Physical Geology.

thirty-four weeks. To count for a full course. To be preceded by subject F 3 (Qualitative Analysis).

Professor Koenig and Mr. Burrall.

-F 5. ADVANCED QUANTITATIVE ANALYSIS. Twelve hours a week, thirty-four weeks. To be preceded by, or accompanied with, subject F 4 (Quantitative Analysis).

Professor Koenig and Mr. Burrall.

F 6. SYNTHETIC CHEMISTRY. Three times a week, thirty-four weeks. To be preceded by subjects F 4 (Quantitative Analysis), F 5 (Advanced Quantitative Analysis), and W 2, (Mineralogy). . Professor Koenig.

G. METALLURGY.

PROFESSOR KOENIG AND MR. BURRALL.

G 1. ASSAYING. One hundred and forty-four hours. To count as a two-fifths course. To be preceded by subject F 3, (Qualitative Analysis).

Professor Koenig and Mr. Burrall.

G 2. METALLURGY. Three times a week, thirty-four weeks. To be preceded by subjects F 3 (Qualitative Analysis), and preceded by, or accompanied with, subjects F 4 (Quantitative Analysis) and W 2 (Mineralogy).

Professor Koenig.

G 3. METALLURGICAL EXPERIMENTATION. Three times a week, thirty-four weeks. To be preceded by subjects F 4 (Quantitative Analysis), G 1 (Assaying), G 2 (Metallurgy), and W 2 (Mineralogy). Professor Koenig.

G 4. METALLURGY AND METALLURGICAL DESIGNING. Nine hours a week, thirty-four weeks. To be preceded by subjects F 4 (Quantitative Analysis), G 2 (Metallurgy), L 4 (Graphical Statics), M 3 (Mechanism), M 5 (Mechanical Engineering), and W 3 (Mineralogy).

Professor Koenig and Mr. Burrall.

L. DRAWING.

PROFESSORS KIDWELL AND SPERR, AND MESSRS. MOORE AND HOULE.

L 1. MECHANICAL DRAWING. Eighteen hours a week for eight weeks, and nine hours a week for twenty-six weeks. To count for a full course. Mr. Moore.

L 2. TOPOGRAPHICAL DRAWING. Twelve hours a week, six weeks. To count as a one-fifth course.
Professor Sperr and Mr. Houle.

L 3. TOPOGRAPHICAL DRAWING (Mapping). Twelve hours a week, six weeks. To count as a one-fifth course. To be preceded by Q 1 (Surveying).
Professor Sperr and Mr. Houle.

L 4. GRAPHICAL STATICS. Nine hours a week, fourteen weeks. To count as a two-fifths course. To be preceded by subjects C 2 (Analytic Mechanics) and L 1 (Mechanical Drawing). Mr. Houle.

L 5. ENGINEERING DESIGN AND CONSTRUCTION. Nine hours a week, twenty weeks. To count as a three-fifths course. To be preceded by subjects L 4 (Graphical Statics), M 5 (Mechanical Engineering), and R 4 (Mining Engineering). Professor Sperr and Mr. Houle.

L 6. MACHINE DESIGN. Twelve hours a week, twenty-six weeks. To count as a full course. To be preceded by subjects M 5 (Mechanical Engineering), M 6 (Testing Materials of Engineering), and accompanied with subjects M 7 (Valve Gears), and M 8 (Thermodynamics).
Professor Kidwell and Mr. Moore.

M.—MECHANICAL ENGINEERING.

PROFESSOR KIDWELL, AND MESSRS. MOORE, SHIELDS AND WASS.

M 1. PROPERTIES OF MATERIALS. Three times a week, twenty weeks. To count as a three-fifths course. To be preceded by subjects B 1 (Physics), and F 1 (General Chemistry.) Mr. Moore.

M 2. SHOP PRACTICE. Forty-five hours a week, eleven weeks. To count for two full courses. To be preceded by subjects L 1 (Mechanical Drawing), and M 1 (Properties of Materials), except in the case of pupils who enter for Shop Practice alone.

Professor Kidwell, Mr. Shields and Mr. Wass.

M 3. MECHANISM. Three times a week, fourteen weeks. To count as a two-fifths course. To be preceded by subjects C 1 (Analytic Mechanics), and L 1 (Mechanical Drawing), and preceded by, or accompanied with, subject C 2 (Analytic Mechanics). Mr. Moore.

M 4. MECHANICS OF MATERIALS. Three times a week, thirty-four weeks. To count as a full course. To be preceded by subjects C 1 (Analytic Mechanics) and M 1 (Properties of Materials), and preceded by, or accompanied with, C 2 (Analytic Mechanics). Mr. Moore.

M 5. MECHANICAL ENGINEERING. Three times a week, thirty-four weeks. To count as a full course. To be preceded by subjects L 1 (Mechanical Drawing) and M 2 (Shop Practice), and preceded by, or accompanied with, subjects C 2 (Analytic Mechanics), M 3 (Mechanism) and M 4 (Mechanics of Materials). Mr. Moore.

M 6. TESTING MATERIALS OF ENGINEERING. Forty-five hours a week, five weeks. To count as a full course. To be preceded by subject M 4 (Mechanics of Materials).

Professor Kidwell and Mr. Moore.

M 7. VALVE GEARS. Twice a week, twenty-six weeks. To count as a one-half course. To be preceded by subject M 5 (Mechanical Engineering) and accompanied with L 6 (Machine Design), and M 8 Thermodynamics.

Professor Kidwell.

M 8. THERMODYNAMICS. Twice a week, twenty-six weeks. To count as a one-half course. To be preceded by subject M 5 (Mechanical Engineering). Professor Kidwell.

M 9. MECHANICAL ENGINEERING—EXPERIMENTAL WORK IN THE MECHANICAL LABORATORY. Forty-five hours a week, eleven weeks. To count as two full courses. To be preceded by subjects L 6 (Machine Design), M 7 (Valve Gears) and M 8 (Thermodynamics). Professor Kidwell.

For further subjects belonging to this department see

L 1. Mechanical Drawing.

L 6. Machine Design.

N. ELECTRICAL ENGINEERING.

PROFESSOR KIDWELL AND MR. MOORE.

N 1. ELECTRICAL ENGINEERING. Three times a week, twenty-six weeks. To count as a four-fifths course. To be preceded by, or accompanied with, subjects B 3 (Electrical Measurements), C 2 (Analytic Mechanics), and M 5 (Mechanical Engineering). Professor Kidwell.

N 2. ELECTRICITY AND MAGNETISM. (Mathematical Theory.) Three times a week, twenty-six weeks. To count as a four-fifths course. To be preceded by subjects B 3 (Electrical Measurements) and N 1 (Electrical Engineering), and to be accompanied with N 3 (Electrical Engineering). Professor Kidwell.

N 3. ELECTRICAL ENGINEERING. Two times a week, twenty-six weeks. To count as one-half a course. To be preceded by subjects B 3 (Electrical Measurements), and N 1 (Electrical Engineering) and accompanied with N 2 (Electricity and Magnetism). Professor Kidwell.

N 4. ELECTRICAL ENGINEERING—LABORATORY PRACTICE. Forty-five hours a week, eleven weeks. To count as two full courses. To be preceded by subjects M 7 (Valve

Gears), N 2 (Electricity and Magnetism) and N 3 (Electrical Engineering). Professor Kidwell.

Q. CIVIL ENGINEERING.

PROFESSOR SPERR AND MR. HOAR.

Q 1. SURVEYING, (Theory and Practice). Forty-five hours a week, eleven weeks. To count as two full courses. To be preceded by subjects A 3 (Spherical Trigonometry) and L 2 (Topographical Drawing), except for those who enter for this work alone, who need to be prepared in Logarithms, Plane Trigonometry and Mensuration.

Professor Sperr and Mr. Houle.

Q 2. HYDRAULICS. Three times a week, twenty weeks. To count as a three-fifths course. To be preceded by subjects A 5 (Calculus), B 1 (Physics), C 1 (Analytic Mechanics), and R 1 (Principles of Mining), and preceded by, or accompanied with, subject C 2 (Analytic Mechanics).

Professor Sperr.

For further subjects belonging to this department see

L 2. Topographical Drawing.
L 3. Topographical Drawing (Mapping).
L 4. Graphical Statics.
L 5. Engineering Design and Construction.

R. MINING ENGINEERING.

PROFESSOR SPERR AND MR. HOULE.

R 1. PRINCIPLES OF MINING. Three times a week, twenty weeks. To count as a three-fifths course. Must be preceded by subject Y 1 (Principles of Geology). Excursions to the mines, etc., required as extras. This subject is required of all candidates for the S. B. and E. M. degrees.

Professor Sperr.

R 2. MINE SURVEYING AND MINING. Two times a week, twenty weeks. To count for two-fifths of a course. To be

preceded by L 3 (Topographical Drawing), Q 1 (Surveying), R 1 (Principles of Mining), and Y 1 (Principles of Geology).
Professor Sperr.

R 3. MINE SURVEYING AND MINING (PRACTICAL WORK). Forty-five hours a week, six weeks. To count as a full course. To be preceded by subject R 2 (Mine Surveying and Mining), except for students who enter for this study alone, who are required to be prepared in Algebra, Geometry, Trigonometry, and in the use of the transit and level.
Professor Sperr and Mr. Houle.

R 4. MINING ENGINEERING. Three times a week, twenty weeks. To count as a three-fifths course. To be preceded by subjects C 2 (Analytic Mechanics), M 3 (Mechanism), R 3 (Mine Surveying and Mining), and Q 2 (Hydraulics.
Professor Sperr.

R 5. MINE MANAGEMENT AND ACCOUNTS. Six hours a week, twenty weeks, to count as a two-fifths course. To be preceded by subjects R 1 (Principles of Mining), and R 3 (Mine Surveying and Mining).
Professor Sperr.

R 6. MINE VENTILATION. Twice a week for twenty weeks. To count as a two-fifths course. To be preceded by M 5 (Mechanical Engineering), and Q. 2 (Hydraulics).
Professor Sperr.

S.—ORE DRESSING.

PROFESSOR SPERR AND MR. BURRALL.

S 1. ORE DRESSING, (THEORY AND PRACTICE). Forty-five hours a week, five weeks. To count as a full course. To be preceded by subjects G 1 (Assaying), M 2 (Shop Practice), Q 2 (Hydraulics), and W 2 (Mineralogy).
Professor Sperr and Mr. Burrall.

V. BIOLOGY.

THE DIRECTOR, ASSISTANT PROFESSOR SEAMAN AND MR. SUTTON.

V 1. BOTANY (GENERAL AND ECONOMIC). Three times a week, eight weeks. To count as a one-fifth course.

The Director.

V 2. ZOOLOGY AND PALÆONTOLOGY. Nine hours a week, fourteen weeks. To count as a two-fifths course.

Assistant Professor Seaman and Mr. Sutton.

W. MINERALOGY.

THE DIRECTOR, ASSISTANT PROFESSOR SEAMAN AND MR. SUTTON.

W 1. CRYSTALLOGRAPHY. Twelve hours a week, eight weeks. To count as a one-fifth course.

Assistant Professor Seaman and Mr. Sutton.

W 2. MINERALOGY. Twelve hours a week, twenty-eight weeks. To count as a full course. To be preceded by subjects B 1 (Physics), F 1 (General Chemistry), F 2 (Blowpipe Analysis), W 1 (Crystallography), and Y 1 (Principles of Geology). Assistant Professor Seaman and Mr. Sutton.

X. PETROGRAPHY.

THE DIRECTOR AND MR. SUTTON.

X 1. PETROGRAPHY (LITHOLOGY AND PETROLOGY). Three times a week, thirty-four weeks. To be preceded by subjects B 1 (Physics), F 1 (General Chemistry), Y 1 (Principles of Geology), and W 2 (Mineralogy).

The Director and Mr. Sutton.

Y. GEOLOGY.

THE DIRECTOR, ASSISTANT PROFESSOR SEAMAN AND MR. SUTTON.

Y 1. ELEMENTS OF GEOLOGY. Three times a week, eight weeks. To count as a one-fifth course. No student will be allowed to take this subject who has an entrance condition in Astronomy. This subject is required of all candidates for S. B. and E. M. degrees. The Director.

Y 2. STRATIGRAPHICAL GEOLOGY. Three times a week, fourteen weeks. To count as a two-fifths course. To be preceded by subjects B 1 (Physics), F 1 (General Chemistry), V 1 (Botany, after 1896–1897), V 2 (Zoology and Palæontology), Y 1 (Principles of Geology), and preceded by, or accompanied with, W 2 (Mineralogy).

Assistant Professor Seaman and Mr. Sutton.

Y 3. PHYSICAL AND CHEMICAL GEOLOGY. Three times a week, fourteen weeks. To count as a two-fifths course. To be preceded by B 1 (Physics), F 1 (General Chemistry), W 2 (Mineralogy) and Y 2 (Stratigraphical Geology), and preceded by, or accompanied with, subject X 1 (Petrography).

The Director.

Y 4. GEOLOGICAL FIELD WORK. Forty-five hours a week, six weeks. To count as a full course. To be preceded by subjects Q 1 (Surveying), L 3 (Topographical Drawing), W 2 (Mineralogy), X 1 (Petrography), Y 2 (Stratigraphical Geology), and Y 3 (Physical Geology), except for those who enter for this study alone.

Assistant Professor Seaman and Mr. Sutton.

Y 5. ECONOMIC GEOLOGY. Three times a week, twenty-eight weeks. To count as four-fifths of a course. To be preceded by subjects R 1 (Principles of Mining), X 1 (Petrography), Y 3 (Physical Geology), and Y 4 (Geological Field Work). The Director.

J. THESIS.

THE FACULTY.

J 1. THESIS. Nine hours a week, thirty-four weeks. To count as a full course. The subject of the thesis is to be selected at the same time that the other electives are chosen. The work is to be done under the direction and with the approval of some instructor or instructors, and both the subject and thesis must be approved by the Director.

The student must have taken all the necessary preparatory work that is required to enable him to properly handle his subject, or it will not be approved by the Director. The instructor or instructors under whom the thesis work is done must have presented to the Secretary a written statement certifying that the student is properly prepared and able in their judgment to accomplish the work specified. This statement is to accompany the elective schedule.

PREPARATORY SUBJECTS.

September, 1895, to June, 1897.

I. ELEMENTARY ALGEBRA. Three times a week, thirty-four weeks. Mr. Fisher.

II. GEOMETRY, PLANE, SOLID AND SPHERICAL. Three times a week, thirty-four weeks. Mr. Fisher.

III. ELEMENTARY PHYSICS, WITH LABORATORY WORK. To be preceded by or accompanied with subjects I (Elementary Algebra) and II (Geometry). Three times a week, thirty-four weeks. Mr. Knox.

IV. BOOK-KEEPING. Three time a week, fourteen weeks. Mr. Fisher.

V. ASTRONOMY. Three times a week, twenty weeks. To be preceded by or accompanied with subjects II (Geometry) and III (Elementary Physics). Mr. Fisher.

DEPARTMENTS OF INSTRUCTION.

DEPARTMENTS OF INSTRUCTION.

A. MATHEMATICS.

PROFESSOR McNAIR AND MR. FISHER.

As will be seen by a detailed examination of the following pages of this catalogue, the subjects of this department form the necessary foundation for a great part of the student's subsequent work; and they are given as a preparation for this work, as well as for their value in actual engineering practice, and in affording mental discipline.

It is the intention, therefore, to give the instruction in this department in such a manner as will place in prominence those subjects or portions of subjects which will be of actual use to the student, and later, to the engineer. It follows that many things, of interest only to the specialist in mathematics, are entirely omitted.

The value of the study of mathematics in developing the power to do vigorous and logical thinking is not lost sight of, but it is thought that the effort to master the logic of the subjects necessary to the engineer will afford the student ample opportunity to develop this power.

Every effort is made to see that the student takes advantage of the opportunity thus offered. At each step of his progress he is required to think. The ability to describe a given method, or to correctly quote a given formula, and to apply either to a given case, is in no instance accepted as sufficient. The student is required to logically derive the method or formula, and to demonstrate its correctness.

Attention is again called to the entrance requirements in this department. The intending student is asked to pay particular attention to the subjects of Factoring, Fractions, Quadratic Equations, Radicals and Indices in Algebra, and to make sure of his understanding of, and familiarity with, each of them.

The courses offered in mathematics are the following:

A 1.—*Algebra.*

MR. FISHER.

The course includes the Theory of Limits, Logarithms, Progressions, Arrangements and Groups, Binomial Theorem, Undetermined Co-efficients, Series, and the Solution of Higher Equations.

Wentworth's College Algebra is used in '95-'96 as the text-book.

Three times a week, thirty-four weeks, to count as a full course.

A 2.—*Plane Trigonometry.*

MR. FISHER.

The ratio system is used exclusively, and prominence is given to the solution of trigonometric equations, and the transformation of trigonometric expressions.

The fall term's work in subject A 1 (Algebra) must precede or be taken along with this course.

Wheeler's Plane and Spherical Trigonometry is used as the text-book.

Three times a week, fourteen weeks, fall term. Counts as two-fifths of a course.

A 3.—*Spherical Trigonometry.*

MR. FISHER.

The solution of Right and Oblique spherical triangles given from the same text-book as is used in subject A 2 (Plane Trigonometry).

Four times a week, first six weeks of the summer term. Counts as one-fifth of a course. Must be preceded by subject A 2 (Plane Trigonometry).

A 4.—*Analytic Geometry.*

MR. FISHER.

The course covers the straight line, conic sections, a few higher plane curves, transformation of co-ordinates, general equation of the second degree, and an introduction to geometry of three dimensions.

The object is to familiarize the student with methods rather than with any set of curves.

Given partly by lectures and partly from Wentworth's Analytic Geometry.

Four times a week, twenty weeks, winter term and first six weeks of the summer term. Counts as four-fifths of a course.

Must be preceded by course A 2 (Plane Trigonmetry) and preceded by, or accompanied with, course A 1 (Algebra).

A 5.—*Differential and Integral Calculus.*

PROFESSOR McNAIR.

The *Differential Calculus* is developed from a rate as its fundamental notion. The *Integral Calculus* is from the beginning treated as a method of summation.

The object of the course is to give the student a thorough working knowledge of the subject—to put him in possession of a tool of which he can afterward make efficient use. It is believed that this can best be accomplished by giving him a rigorously logical basis for his methods and formulas, and the attempt to do this is therefore made.

Applications of differentiation to Expansion in Series, Indeterminate Forms, Maxima and Minima, etc., are treated; while problems of Area, Volume, Work, etc , introduce the subject of integration, and their treatment is carried along simultaneously with that of methods.

The Calculus is given partly by lectures, with printed notes, and partly from Taylor's Elements of the Calculus.

Four times a week, twenty-eight weeks, fall and winter terms. Counts as a full course.

Must be preceded by course A 4 (Analytic Geomety).

A 6.—*Introductory Differential Equations.*

PROFESSOR McNAIR.

An introduction to Differential Equations which will include the treatment of those special equations which the student will meet in his study of Mechanics and Electricity.

The course is given by lectures and recitations.

Four times a week, first six weeks of the summer term. Counts as one-fifth of a course.

Open to those who have credit for course A 5 (Calculus).

B.—PHYSICS.

PROFESSOR McNAIR AND MR. KNOX.

The aim in the department of *Physics* as in that of *Mathematics* is to select such subjects as have, directly or indirectly, a bearing on the practical work of the mining engineer, and to treat these in as practical a manner as possible.

The instruction is given by the laboratory method. The student goes at once into the laboratory and there, under the direction of the instructors, experiments for himself. The experiments are mostly quantitative, he being required to measure and give a definite account of the quantity with which he is dealing.

As far as possible, mere mechanical following of directions is excluded, and intelligent thinking is made necessary to the accomplishment of the work. Every effort is put forth to have the student clearly develop and fix in his mind the principles of Physics which he will afterward use, and also to lay the foundation for that skill in accurate determination of quantity, and care of delicate apparatus, which are needed by the practical engineer. Accuracy and order are insisted on from the first. Each student receives individual attention, and, with the exception of a few experiments requiring more than one observer, he does his work independently of all other students.

The work of the laboratory is accompanied by illustrated lectures, and by such text-book and recitation work as is found necessary.

Below is given a partial list of the equipment of this department for lecture illustration and laboratory work. Besides the apparatus here listed, the department possesses the usual outfit of battery cells, magnets, lenses, thermometers, and other minor apparatus.

Physical Apparatus.

Four sets of apparatus for experimental verification of the laws of composition and resolution of forces.

Twelve Vernier Calipers.
Twelve Micrometer Calipers.
Twelve small Spherometers.
One large Spherometer.
One Cathetometer.
One Atwood Machine.
Two sets Pendulums.
One Whirling Table and Accessories.
One "Swiftest Descent" Apparatus.
Two sets Moment of Inertia Apparatus.
One Clock Electrically Recording Seconds.

VE WEEKS—JUNE, JULY.	SCHEDULE: SIX WEEKS—JULY, AUGUST.
RS—8-12; 1-6.	HOURS—8-12; 1-6.
Practice. ng Materials. anical Laboratory. rical Laboratory. ying. Dressing.	M 2. Shop Practice. M 9. Mechanical Laboratory. N 4. Electrical Laboratory. Q 1. Surveying. Y 4. Field Geology.
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Six sets Apparatus for Determining Modulus of Elasticity.
Six Kohlbusch Balances.
One Becker Balance.
One Springer Torsion Balance.
Six Troemner Balances.
Five Jolly Balances.
One Hydrostatic Balance.
Four Mohr-Westphal Specific Gravity Balances.
Twenty-four Specific Gravity Bottles.
Six Nicholson's Hydrometers.
Four Baume Hydrometers.
One Ritchie's Rotary Air Pump and Accessories.
One Lever Air Pump.
One Fortin's Barometer.
Two Aneroid Barometers.
Two Mariotte's Law Apparatus.
Two Condensing and Exhausting Pumps.
One Anemometer.
Seven Sonometers.
Six Vibrating Forks and Resonators.
One Savart's Toothed Wheel Apparatus.
One Lissajous' Apparatus.
One Set Singing Flame Apparatus.
Twelve Sets Apparatus for Velocity of Sound.
Twelve Sets Apparatus for Calibrating Thermometers and Determining Specific Heats.
One Pyrometer.
One Set Natterer Tubes.
One Maximum and Minimum Thermometer.
Thirty Calorimeters.
One Achromatic Prism.
Eight Geneva Spectra-Goniometers.
Twelve Prisms for same.
One Plane Rowland Grating with Mounting.
One Glass Grating for Projection of Spectra.
One pair Tourmaline Pincets.
One Table Polariscope with Convergent Ring System.
One Single Electric Projection Lantern.
One Combined Microscope and Polariscope fitted to same.

One Newton & Co's Bi-Unial Optical Lantern, complete with gas jets and arc lamp.

One Wright's Projecting Polariscope by Newton & Co.

One set Specimens for projecting Polariscope.

One Projecting Micro Polariscope by Newton & Co.

One Wright's Refraction Tank for Optical Lantern.

One Wright's Wave Apparatus for Optical Lantern.

One Moore's Wave and Beat Apparatus for Optical Lantern.

One Huyghen's Apparatus for Optical Lantern.

One Newton's Ring Apparatus for Projection.

One Bunsen's Photometer.

Three Bradley's Marine Sextants.

One Heath & Co.'s Sextant with Artificial Horizon.

Twelve Plain Reading Telescopes with Scales.

Eight Geneva Reading Telescopes with Scales.

One Lamp and Scale.

One Electromagnet.

One Electrophorus.

One Toepler-Holtz Machine.

One Gold-Leaf Electroscope.

One Elliot Brothers' Quadrant Electrometer.

Six Leyden Jars.

Six Copper Voltameters.

Six Volume Voltameters.

Four Sets Geissler Tubes.

One Clamond's Thermo-Battery.

Two Thermopiles.

Twelve Calorimeters with Resistance Coils.

Seven Astatic Pointer Galvanometers.

Four Mirror Galvanometers with Interchangeable Long and Short Coils.

Four Mirror Galvanometers with Long Coils.

Twelve Tangent Galvanometers with Long and Short Coils.

Three Tangent Galvanometers, Helmholtz-Gaugain form.

One Single Ring Tangent Galvanometer.

One Focault Apparatus.

Four sets Primary and Secondary Coils.

One small Induction Coil.

One large Induction Coil.

Five Earth Inductors.

One small Hand Dynamo.

Five small Electro-Motors.

One Continuous Rheostat, Lord Kelvin's Form.

One Kohlrausch Universal Rheometer.

Seven Meter Bridges.

Eight Box Wheatstone Bridge and Resistance Sets, range 1-100 to 11,110 ohms.

One Portable Testing Apparatus, range 0.0002 to 555555 ohms.

The courses offered by the department of Physics are as follows:

PROFESSOR McNAIR AND MR. KNOX.

An elementary course including Mechanics, Heat, Light, Magnetism, and Electricity. Lecture, recitation, and laboratory work proceed together throughout the course.

Text-books are Lock's Mechanics for Beginners, Glazebrook's Heat and Light, Thompson's Electricity and Magnetism, Sabine's Laboratory Manual, and printed lecture notes. The geometrical side of Light is developed mostly in the laboratory, the wave theory and polarization in the lecture room with the optical lantern and the arc light.

Twelve hours a week, thirty-four weeks. To count as a full course. Must be preceded by, or accompanied with, subjects A 1 (Algebra), and A 2 (Plane Trigonometry).

B 2.—*Physical Measurements.*

PROFESSOR McNAIR AND MR. KNOX.

A more advanced course in measurements of precision, open to those who have taken subjects A 5 (Calculus), and B 1 (Physics).

The work offered will be mainly in the determination of densities, moments of inertia, calorimetry and photometry.

Each student will work independently of all others, and to a considerable extent the choice of the line of work he is to pursue will lie with him.

Text-books are Nichol's Manual of Laboratory Physics, and Stewart & Gee's Elementary Practical Physics, Vols. I and III.

Twelve hours a week, first six weeks of the summer term. Counts as one-fifth of a course.

B 3.—*Electrical Measurements.*

PROFFSSOR MCNAIR.

The increasing use of electricity in mining and related industries has caused the Michigan Mining School to enlarge somewhat its facilities for giving instruction in this subject.

The course in Electrical Measurements is offered to those who are making Electrical Engineering their principal subject, those who intend taking up Electrolytic or Electro-metallurgical work, and to any others who wish to become familiar with those modern methods of electrical measurement necessary wherever there is made any practical application of this agent.

In the course are included the measurement of Current, Resistance, Potential Difference, Electromotive Force, Quantity, Capacity, Mutual and Self Induction, Strength of Field, etc.

In the lecture room the theory of a given measurement is taken up; then the construction and calibration of the instrument used in the measurement are studied, the instrument being at hand for inspection; and finally, in the laboratory, the student calibrates, if necessary, and uses the instrument in making the measurement.

Examples of all of the principal instruments used in modern electrical methods are owned by this institution, and are available for the work of this course. Among them may be mentioned a Kelvin Composite Balance; a Siemens Electrodynamometer; a Weston Portable Ammeter; a vertical Magnet D'Arsonval Galvanometer with Shunt Box; a Differential D'Arsonval Galvanometer; a Queen Horizontal Magnet D'Arsonval Galvanometer; eight Kohlrausch Differential Galvanometers by Hartman and Braun; a Willyoung Thomson Astatic Galvanometer; a Willyoung Ballistic Galvanometer; two Rowland D'Arsonval Galvanometers with Ballistic Systems by Willyoung & Co.; an Ayrton Shunt Box; a Special Meter Bridge by Willyoung & Co.; a Queen Anthony Bridge and Resistance Set; two Standard B. A. Units by Elliot Brothers; a Crompton Potentiometer, station class, with Standard Resistances for Current Measurement, by Crompton & Co.; a Weston Portable Direct Voltmeter; a Weston Portable Alternating Current Voltmeter; a Marshall Standard One Microfarad Condenser; a variable Standard of Self Induction; and a Double Deflector Magnetometer.

The Text-books are Carhart and Patterson's Electrical Measurements, and Nichol's Laboratory Manual.

Three times a week, thirty-four weeks. To count as a full course. Must be preceded by subjects B 1 (Physics) and C 1 (Analytic Mechanics).

MECHANICS.

PROFESSOR McNAIR.

An attempt is made in Mechanics to develop the essential principles, and to render the student proficient in applying them to practical rather than theoretical problems. To this end a large number of problems are solved, which, so far as possible, are selected from machines or structures with which the student is already familiar, or the study of which he is subsequently to take up.

C 1.—*Analytic Mechanics.*

PROFESSOR McNAIR.

Church's Mechanics of Engineering, Parts I and II, Statics and Dynamics, is made the basis of this and the following course.

Subject C 1 is given three times a week for fourteen weeks, in the winter term. Counts as two-fifths of a course.

It must be preceded by subject B 1 (Physics), and preceded by or accompanied with, subject A 5 (Calculus).

C 2.—*Analytic Mechanics.*

PROFESSOR McNAIR.

Subject C 2 continues the work begun in subject C 1 and is given three times a week, fourteen weeks, in the fall term. Counts as two-fifths of a course.

It must be preceded by subject C 1 (Analytic Mechanics).

CHEMISTRY.

PROFESSOR KOENIG AND MR. BURRALL.

The instruction in chemistry is designed to excite in the student a love for experimentation and to train him in inductive thinking. If this aim can be reached, or if it can only be approximated, it is believed that the gain to the student will be great, much greater than the accumulation of any number of facts might be to him. For all the modern advancement in the subjugation of Nature's forces is owing to experiment, and we know from the autobiographical statements of many inventors of genius, that they lost the labor of years through the lack of training in properly correlating the results of their experiments.

In carrying out the plan of this course it has been found necessary and useful to abandon the use of text books altogether. For no matter how such a text-book be written and arranged it will present to the beginner the science of chemistry as a finished edifice, very wonderful and very intricate in its details. The study of it thus becomes of necessity mechanical; the memory is loaded with facts and figures, and the thinking faculties become numbed rather than quickened. Experience of years has shown, that even a set of notes will have a similar effect on the student. The best results are obtained when the teacher builds up the science from experiment, by making suggestions leading the student to experiment on similar bodies in his own way. In this course there are no definitions to start with of atoms, molecules and structural formulae. By means of a proper selection of common bodies, the student not only discovers the qualitative and quantitative relations of matter, the simple and compound bodies, but he reveals his very reagents as he goes along; he comes to compare and correlate the phenomena; he finally classifies the phenomena, and works up to the evolution of their laws. It is not claimed that any and all brain organizations will become thinking instruments under this system. But it is claimed that it will greatly stimulate and improve existing faculties.

F 1.—*General Experimental Chemistry.*

PROFESSOR KOENIG AND MR. BURRALL.

Nine hours a week for twenty-eight weeks; one recitation, two lectures, and six hours of laboratory work each week; to count as a four-fifths course.

The instruction in this subject covers the following ground:

First. Experiments with the common metals, their action when heated in air, and when heated in the absence of air; discovery of the composite nature of air: a life sustaining part (ozone); a life destroying part (azote). Specific gravity of azote by direct weight and of ozone by calculation. The increase in weight of metals when heated in air, discovery of ozonites (oxides). Ratio of increase. Burning of sulphur in air, discovery of a gaseous sulphur ozonite possessing an acid taste; change of the name ozone into oxygen. Restoration of the original metals from the ozonites by the action of charcoal; hence the notion of elements or simple bodies. Action of the common metals at a red heat upon steam, the forming of bodies similar to the oxides and of an inflammable gas; discovery of hydrogen and its properties. Proving the identity of water-oxides with air oxides, hence the conclusion that water is a combination of oxygen with hydrogen.

Second (1.) The study of copperas or vitriol. Under the action of heat it yields an oily liquid—the oil of vitriol. Correlation of this body with the sulphur oxide. With the oil of vitriol the student has gained now a powerful reagent, but he does not know, and should not be told at this stage of his development, that this oil of vitriol is $H^2 SO^4$. The body is for his purposes simply oil of vitriol for which the symbol O' may stand.

(2.) Study of potash, soda ash, limestone. Their action with heat, with heat and charcoal, with oil of vitriol. Their action upon each other; of burnt lime upon potash. Discovery of potassium, sodium, calcium, and of caustic soda, caustic potash and of a non life-sustaining, heavy, slightly sour gas, lime gas (not CO^2). Alkaline reaction, acid reaction; the notion of hydroxides, of acid hydroxides and of basic hydroxides.

(3.) Study of common salt, the mother-liquor salt and the varec salt. The spirits of salt. Decomposition into a green gas and hydrogen. Chlorine probably a simple body. Bromine, iodine, fluorine. Action of chlorine upon hydrogen in equal volumes. The theory of combinations by volumes; the notion of *molecules* and *atoms*; of molecular weights and atomic weights. The action of chlorine upon the common metals—the chlorides, their properties. Reproduction of salt by acting with spirits of salt upon soda-ash—hence the identity of the metal in salt and soda-ash. Atomic weight of sodium and potassium by experiment.

(4.) The study of nitre. Action in heat. Yields a gas which sustains combustion and animal breathing. Identification of this gas with the ozone or oxygen of the air. The notion of super or peroxides. The spirits of nitre. Its action upon the metals. Discovery of nitrogen and identification of this gas with the azote of the air. The several oxides of nitrogen. Nitrogen chloride. Action of zinc and caustic potash upon nitre. Discovery of a gaseous alkaline body. Ammonia. Study of its properties and combinations; ammonium salts.

(5.) The study of sulphur. The oxides and chlorides of sulphur. The manufacture of hydrogen sulphate.

(6.) Discovery of carbon by decomposing the limestone gas with sodium. Identification of this body with the substance of charcoal, of mineral coal, of plant and animal structures. The mineral oils, the natural gases. The fats, alcohols, ethers, albumenoid bodies. Discovery of cyanogen and its principal compounds.

(7.) The study of bone-ash and discovery of phosphorus-oxides and hydroxides of phosphorus.

(9.) The study of borax and quartz; boron and silicon.

(10.) Theoretical deductions. Electrolysis. Thermo-chemistry. Structural and stereographic formulæ.

The students are required to take notes during the lectures, and they must keep a detailed account of their own observations and deductions in the laboratory. The term standing is derived from these notes and from the recitations, which are held once a week.

F 2.—*Blowpipe Analysis.*

PROFESSOR KOENIG AND MR. BURRALL.

Twelve hours per week for six weeks. Two lectures, one recitation and nine hours of laboratory work each week. To count for one-fifth of a course.

This is a short course in Qualitative Analysis in which preference is given to reactions in the igneous way, so that students may be enabled to take the course in Mineralogy with full benefit.

Brush's tables and Landauer's small treatise are referred to.

To be preceded by subject F 1 (General Chemistry).

F 3.—*Qualitative Analysis.*

PROFESSOR KOENIG AND MR. BURRALL.

Nine hours a week for twenty-eight weeks. Two lectures, one recitation, and six hours of laboratory work each week.

To count for four-fifths of a course.

This course comprises the chemistry of the metals. The students are to make the salts of the metals and then compare the differences existing in the same classes, whereby they are enabled to understand the reasons upon which the schemes for separation are based. The use of the spectroscope is introduced. More intricate blowpipe reactions than those taken in subject F 2 (Blowpipe Analysis), such as the separation of manganese, iron, cobalt, nickel and copper, in the form of arsenides, are studied.

Elliott's tables are used as a guide.

Must be preceded by F 1 (General Chemistry), and F 2 (Blowpipe Analysis).

F 4.—*Quantitative Analysis.*

PROFESSOR KOENIG AND MR. BURRALL.

Twelve hours a week for thirty-four weeks. Two lectures, one recitation, and seven hours of laboratory work a week. To count as a full course.

The course opens with volumetric analysis: acidimetry, alkalimetry and permanganate methods. volumetric analysis of limestones. Analysis of copper ores: gravimetric, volumetric, colorimetric and electrolytic methods. Analysis of iron ores. In the soluble portion there are determined volumetrically, the elements iron, manganese, phosphorus. In the insoluble portion there are determined gravimetrically: SiO^2, TiO^2, Cr^2O^3, Al^2O^3, Fe^2O^3, MnO^2, CaO, MgO. The material for this analysis is prepared and mixed artificially so that all the bodies appear in weighable proportions. In separate portions are determined sulphur (by fusion with nitre and sodium carbonate), carbon dioxide and water. It will be seen that the analysis covers all the operations of silicate analysis, except the alkalies, and therefore a separate analysis of furnace slag is not needed, to teach its methods.

Analysis of a matte containing arsenic, antimony, tin, bismuth, silver, copper, lead, cadmium, zinc, iron and sulphur. Analysis of pig iron for graphite, combined carbon, managnese, phosphorus and sulphur.

Analysis of steel. Determination of carbon by the copper, ammonium chloride, wet and dry combustion, and colorimetry process; manganese by colorimetry; phosphorus by molybdic solution and titration with permanganate solution; sulphur by bromine method; and finally determination of silicon. The lectures cover a more extended range of analytical methods, but the students are not required to complete any work aside from that given above. Fresenius's Quantitative Analysis is used as a book of reference. Professor Koenig's notes also are followed in the work.

Must be preceded by F 3 (Qualitative Analysis).

F 5.—*Advanced Quantitative Analysis.*

PROFESSOR KOENIG.

Twelve hours a week for thirty-four weeks. One lecture, one recitation and eight hours of laboratory work a week. To count as one full course.

This course embraces: the analysis of fats, oils and soaps; the extraction and estimation of poisons; the analy-is of fertilizers. the analysis of explosives; the estimation and separation of the rare elements in minerals; analysis of samarskite; nitrometry, and oxygenometry. Theoretical chemistry.

Must be preceded by, or accompanied with, F 4 (Quantitative Analysis).

F 6.—*Synthetic Chemistry.*

PROFESSOR KOENIG.

Eighteen hours a week for thirty-four weeks. To count as two full courses. Candidates must have completed subjects F 4 (Quantitative Analysis), F 5 (Advanced Quantitative Analysis) and W 2 (Mineralogy).

This course is intended as an amplification of the course in General Chemistry, or to cultivate the field of original discovery and invention, or to produce with known reactions a desired commercial result. Students who wish to take this course must have shown by their previous work that they possess the required originality of mind and practical sense. To all others it is a waste of time. The students are required to read much chemical literature and to discuss their reading in a seminar to be appointed from time to time. The subjects of experimentation may either originate with the student or may be suggested by the professor.

The student must keep a minute account of all his work, in arranging the apparatus, as well as in the actual experiment, whether the latter be a failure or a success.

G. METALLURGY.

PROFESSOR KOENIG AND MR. BURRALL.

G 1.—*Assaying.*

PROFESSOR KOENIG AND MR. BURRALL.

One hundred and forty-four hours as follows:

Twenty-four lectures, once a week, and one hundred and twenty hours of laboratory work.

To count as two-fifths of a course.

The laboratory work may be done at any time during the winter term or during the first six weeks of the summer term, provided that the student puts in at least four hours a day of consecutive work.

The furnace assaying comprises: silver ores by scorification and crucible methods; gold ores by roasting and crucible fusion, by nitre in crucible fusion, by lead oxide in crucible fusion; lead ores by iron precipitation and by roasting; native copper concentrates and slimes, by crucible fusion; tin ores by German method; by potassium cyanide method; by Professor Koenig's method (reduction in hydrogen and the loss of weight giving percentage of tin, after having previously removed all reducible and volatile bodies by roasting and extraction with boiling hydrogen chloride).

The assaying in the humid way comprises: bullion assaying; titration according to Gay-Lussac, and Volhard; parting by quartation; zinc ores by the potassium ferrocyanide method; lead ores by Professor Koenig's universal method.

The ore samples used in this assay work are mostly artificial mineral mixtures most carefully prepared, so that the difficulties and losses which are inherent in the different methods may be fully comprehended by the student.

Must be preceded by subject F 3 (Qualitative Analysis).

G 2.—*Metallurgy.*

PROFESSOR KOENIG.

Three times a week for thirty-four weeks, or two lectures and one recitation a week. To count as one full course.

It is the intention that the student acquire in this course the principles and practice of modern methods in the extraction of the technically useful metals. For those who intend to follow metallurgy as a specialty it is to be the broad foundation upon which to raise their further education. Others will through it be enabled to read understandingly the technical advances in the current literature.

The instruction covers the following subjects:

(1.) Fuel: gas versus oils and solid coal, its technical and economical aspects; essential and unessential parts in gas generator; smokeless combustion. Coking. The physical and chemical qualtities of pig iron. Relations between the compostion of iron ores and the resulting pig iron. The chemistry of tho blast furnace. Calculation of cinder or slag compositions. Influence of the profile, cross sections and height of the blast furnace upon the qualtities and quantity of the product.

(2.) Dry puddling. The Bessemer process. The Thomas-Gilchrist process.

(3.) Wet puddling; the common puddling furnace; the rotary puddlers; the open hearth process. Washing out of phosphorus. Washing out of sulphur by manganese. Crucible steel; cement steel; Mushet steel, chrome steel; phosphor steel. Theory of the tempering process Malleable cast iron. Ferro-silicon in steel-casting. The Harvey process. Aluminum in melting and casting wrought iron.

(4.) The metallurgy of lead, copper, silver, gold. The Muldener-Huette Process. Desilverization of work lead by zinc and aluminum. Cupellation. The refining of copper matte. Separation of copper, silver and gold by electrolysis of the matte, or of the black copper by Ziervogel's process.

(5.) The leaching process: sulphate leaching; brine leaching; copper—sodium hyposulphite leaching, potassium cyanide leaching and other chemical possibilities. Chlorination in the dry way by Stettefeldt's furnace; by Bruckner's furnace and its modifications. In the wet way according to Plattner, Meass and Koenig. Amalgamation. Refining of crude bullion; parting of gold and silver.

The metallurgy of zinc and aluminum.

To be preceded by F 3 (Qualitative Analysis) and preceded by, or accompanied with, F 4 (Quantitative Analysis) and W 2 (Mineralogy).

G 3.—*Metallurgical Experimentation.*

PROFESSOR KOENIG.

Nine hours a week for thirty-four weeks. To count as one full course. There are no lectures in this course; the work is wholly experimental. Students must have completed subjects F 4 (Quantitative Analysis). G 1 (Assaying), G 2 (Metallurgy), and W 2 (Mineralogy).

The student may choose among the following subjects:

(1). Comparative extraction of gold ores by amalgamation, by chlorination, and by the smelting process; that is to say, to prove by experiment which of the foregoing methods will yield the highest percentage of gold from a given gold ore.

(2). Comparative extraction of silver ores by amalgamation or leaching.

(3). Electrolysis of ores or secondary products either in aqueous or igneous liquefaction.

(4). The influence of small quantities of negative elements upon the physical properties of metals and metallic alloys.

(5). Microscopic study of metals and alloys.

After the student has chosen the subject of his investigation, he will be required to read all the more recent literature upon the subject, and to extract, condense and digest the same. The Professor will discuss the methods of investigation with the student and a plan will be fixed upon as to the kind and sequence of the experiments. The experience which a student may gain in this work is of great value to him in conducting a testing laboratory and in taking upon himself the superintendence of any metallurgical plant.

G 4.—*Special Metallurgy and Metallurgical Designing.*

PROFESSOR KOENIG AND MR. BURRALL.

Nine hours a week for thirty-four weeks. To count a full course. Candidates for this course must have completed subjects F 4 (Quantitative Analysis), G 1 (Assaying), G 2 (Metallurgy), L 4 (Graphical Statics), M 3 (Mechanism), M 5 (Mechanical Engineering), and W 2 (Mineralogy).

One lecture a week on special metallurgical subjects. The practical part of the work comes under two heads:

1. The student is directed to analyze sectional drawings of fur-

naces, in regard to number, shape and dimensions of parts, and their relation to the temperature and chemical action of the solids and gases which come in contact with them.

2. Designing of a complete plant for the reduction of a given ore and certain topographical features of the locality. Estimation of the required power; arrangement of the machinery as to economy of space and economy of manual labor in the successive operations; estimated cost of the plant.

L. DRAWING.

PROFESSORS KIDWELL AND SPERR AND MR. MOORE AND MR. HOULE.

The instruction in Drawing is designed to give special prominence to such branches of the subject as are of most value to the engineer, hence perspective, shades and shadows, etc., are excluded, and all the time is devoted to mechanical and topographical drawing, and their applications. The following schedule shows details of courses:

L 1.—*Mechanical Drawing.*

MR. MOORE.

(a). DESCRIPTION, PREPARATION AND TESTING OF DRAWING INSTRUMENTS AND MATERIALS: Graphical solution of geometrical problems. Descriptive Geometry. Projections on right and oblique planes; intersections of lines, surfaces, and solids; plans, elevations and sections; isometric and cabinet projection.

Anthony's Elements of Mechanical Drawing.

Lettering; Soennecken's system of round writing. Roman, Italic, Gothic, block, and free hand lettering.

(b). CONSTRUCTION DRAWING: Making of complete working drawings of various details of machine work and timber construction, from rough sketches, or from the model. Tracing and blue printing.

Anthony's Machine Drawing is used as a text-book.

(c). FREE-HAND SKETCHING: Making working sketches, with all necessary views, sections, dimensions, etc., of pieces of machinery or timber constructions assigned by the instructor. This work must be done by the student outside of the class hours, in a book of sectioned paper devoted exclusively to this subject, and turned in for inspection on the date set by the instructor.

Eighteen hours a week for eight weeks and nine hours a week for twenty-six weeks. Subject L 1 must be taken as a whole, and counts as one full course.

Instruments and Materials Needed by Students.

For the convenience of those who desire to purchase their drawing outfit before coming to Houghton, the following list has been prepared.

The articles called for in this list are necessary for a proper prosecution of the course, and care should therefore be taken to get the exact instruments specified, or others of *equal grade.* Those without experience in judging such material are strongly advised to adhere strictly to these lists. Experience has shown that almost invariably when the list has been disregarded the result has been that inferior instruments have been purchased, at a greater cost than necessary to obtain the quality here called for. *Instruments not up to standard will not be allowed in the Drawing Room*, as they will not give satisfaction, and will waste the time of both instructors and students.

Instruments to be got by those who wish to take the work in Mechanical Drawing, and the subsequent course in Machine Design.

One 5-inch Alteneder improved right line pen, or No. 695, Keuffel-Esser 5¼-inch drawing pen.

One 5½-inch Alteneder dividers (pivot joint) with hair spring, pen, pencil, points, and extension bar.

One 3-inch Alteneder bow pen, or No. 486 Keuffel and Esser 3½-inch bow pen and needle point.

One 3-inch bow pencil, or No. 487 Keuffel and Esser 3½-inch spring bow pencil and needle point.

One 3-inch bow dividers, or No. 485 Keuffel and Esser spring bow dividers.

One 6-inch brass protractor.

One 12-inch triangular scale, divided into twelfths.

One T square, 30-inch blade.

One 8-inch 30 x 60 degree rubber or amber triangle.

One 8-inch 45 degree rubber or amber triangle.

One K. & E. curve, No. 1820–20.

One dozen German silver thumb tacks, ⅜ diam,

One bottle Keuffel and Esser's Columbia indelible black drawing ink.

One bottle Keuffel and Esser's Columbia indelible carmine drawing ink.

Two rubber *pencil* erasers.

One piece Artist's gum ¼ x ½ x 3 inches.

Three Faber's artist's 6H pencils.

One bottle paste with brush.

One medium-sized sponge, fine quality.

One Arkansas stone, about ¼ x ⅝ x 3 inches.

Six cabinet saucers, about 2½ inches diameter.

One piece chamois skin, about 12 x 18 inches.

One Soennecken Round Writing Copy Book, and a box of selected pens, with holder.

One-half pan each, moist colors, as follows: Prussian blue, carmine, gamboge, Payne's gray.

Three dozen No. 1 Spencerian pens, with holder.

A black enameled tin box, 13 x 8 x 4 inches, with lock, in which instruments can be kept, is strongly recommended.

A drawing board and two sable brushes will also be required.

Owing to liability of getting sizes that will not answer, these latter should be purchased in Houghton.

L 2.—*Topographical Drawing.*

PROFESSOR SPERR AND MR. HOULE.

This subject precedes the work in Surveying, and is designed to teach the student by means of lectures and practical work the art of lettering, plotting by protraction and rectangular co-ordinates, making scales and topographical signs.

Twelve hours a week, for six weeks. To count as a one-fifth course.

L 3.—*Topographical Drawing (Mapping).*

PROFESSOR SPERR AND MR. HOULE.

This subject follows the work in Surveying, and the student makes his maps from the notes taken in the field by himself.

Twelve hours a week, for six weeks. To count as a one-fifth course. To be preceded by Q 1 (Surveying).

Instruments to be procured by those who wish to take Topographical Drawing.

One 5-inch Alteneder improved right line pen.

One Alteneder swivel curve pen.

One 5½-inch Alteneder dividers (pivot joint) with hair spring, pen, pencil points, and extension bar.

One 3-inch Alteneder bow pen.

One 3-inch bow pencil.

One 3-inch bow dividers.

One 6-inch brass protractor.

One 12-inch triangular decimal scale.

One T-square, 30-inch blade.

One 8-inch, 30 x 60 degree rubber or amber triangle.

One 8-inch, 45 degree rubber or amber triangle.

One K. & E. Curve, No. 1820 1-6.

One dozen German silver thumb tacks, 3-8 diam.

One bottle Higgin's waterproof carmine ink.

One bottle Higgin's waterproof India ink,

Two rubber pencil erasers.

One piece artist's gum 1-2 x 1-2 x 3 inches.

Three Faber's artist's 6H pencils.

One Arkansas stone, about 1-4 x 3-4 x 3 inches.

One piece chamois skin, about 12 x 18 inches.

One-half pan moist Prussian blue.

Three dozen No. 1 Spencerian pens, with holder.

A black enameled tin box, 13 x 8 x 4, with lock, in which instruments can be kept, is strongly recommended.

A drawing board and two sable brushes will also be required. *Owing to liability of getting sizes that will not answer, these latter should be purchased in Houghton.*

L 4.—*Graphical Statics.*

MR. HOULE.

Nine hours a week for fourteen weeks. To count as two-fifths of a course.

This subject is designed to teach the theory of the graphical analysis of stresses in structures, and leads up to the subject of Engineering Design and Construction (L 5). The instruction is given by lectures, following Greene's Roof Trusses, although the principal part of the time is spent in the Drawing Room analyzing trusses, using the lectures and text-book as guides.

This subject must be preceded by L 1 (Mechanical Drawing) and by C 2 (Analytic Mechanics).

L 5.—*Engineering Design and Construction.*

PROFESSOR SPERR.

The work in designing is applied to the shaft head-frames, rock houses, engine and boiler houses, bridges, trestles, etc., of the mining plants considered under the subject R 4 (Mining Engineering).

A general outline of the work is as follows:

1. The general requirements of the structure.
2. Drawing the general plans.
3. The materials best adapted to the various purposes.
4. Strength of materials.
5. Methods of construction.
6. Making detailed drawings, bills of material, and estimates of cost.
7. Synopsis of the law of contracts.
8. Drawing up specifications.
9. Letting contracts.
10. Superintending the construction.

Nine hours a week, twenty weeks. To count as three-fifths of a course. To be preceded by subjects L 4 (Graphical Statics) and R 4 (Mining Engineering).

L 6.—*Machine Design.*

PROFESSOR KIDWELL AND MR. MOORE.

Determination of proper proportions for various minor machine details, such as screws, bolts, nuts, keys, and cotters. Pipes and joints, for gas, water and steam. Power-transmitting machinery:—shafts, pulleys, clutches, hangers; belt, rope, and wire rope gearing; toothed gearing. Designing of engine and boiler details, thereby applying in actual design the principles laid down in subjects M 5, M 7 and M 8. Low and Bevis' Manual of Machine Drawing and Design, and Unwin's Machine Design. One hour lecture, and eleven hours in Drawing Room, per week, twenty-six weeks. To count as one full course. To be preceded by subjects M 5 (Mechanical Engineering) and M 6 (Testing Materials of Engineering) and accompanied with subjects M 7 (Valve gears) and M 8 (Thermodynamics).

In addition to the regular courses in Drawing and Designing, numerous applications of the subject are obtained in connection with the other courses; the students are required to prepare working plans and sections of a mine from their own survey, make a map and profile of a railroad surveyed by themselves, and to draw sections, diagrams, maps, etc., in their geological field work.

Much personal instruction is given in connection with all the above mentioned courses. In addition to the regular lectures and recitations the professors or some of their assistants are present in the Drawing Room during the hours prescribed for practical work, to give advice and personal instruction to those who need it.

Those who desire to enter as special students to take Drawing only. or Drawing in conjunction with some other subject, may do so, provided the professor in charge of the course is convinced of their competency to profit by the instruction. To take up Drawing with success, *Plane, Solid and Spherical Geometry* should have been mastered. In case these subjects have not been completed, the professor under whose direction the student is working will prescribe as a necessary part of the work, the courses in Mathematics which should precede the work in Drawing.

Draughting Room and Equipment.

The Draughting Room is located in the new Engineering Hall, and is 25 x 97 feet, with a 28 x 34 foot annex containing instructors' offices, blue print room, lavatory, etc. The room is on the north side of the building, thereby insuring perfect freedom from shadows at any part of the day. It is provided with electric lights so arranged as to permit night work with the minimum of discomfort. The drawing tables have been so planned that each student has private lockers for his materials, and a rack for his board and T-square. There are two blue printing frames, capacity 3 x 4 feet, a number of smaller frames, for both tracings and photographic negatives, two large vats for developing prints, drying rack, etc. There are also cut models of pumps, injectors, valve gears, structural material, wire ropes, drawings of machinery, buildings, models of trestles and docks, etc., used as illustrative material in the various courses.

M. MECHANICAL ENGINEERING.

PROFESSOR KIDWELL AND MR. MOORE.

Since the successful and economical operation of any mine depends so largely upon the judicious selection, proper design, and skilful operation of its power plant and general machinery, the Mining School offers a course in Mechanical Engineering which covers all the ground necessary fully to prepare the student to take up such work. But as the fundamental principles of Mechanical Engineering are the same, whether the application be made to Mining, or any other industry, it has been possible so to design the course that it gives the student a thorough preparation, and points out to him the methods of study and observation to be followed after graduation, should he decide to take up *any* branch of Mechanical Engineering as his specialty.

Throughout the whole course the attempt is made to present clearly the theory underlying each part of the subject, and then to fix the theory by practical exercises, either in the Mechanical Laboratory, or in the course in Designing. The following subjects are now offered:

M 1.—*Properties of Materials of Engineering.*

MR. MOORE.

General qualities of metals; cast and wrought iron, steel, copper, brass and bronzes; lime, cement, concrete and brick; paints, etc.; timber, and cordage.

Three times a week, twenty weeks, to count as a three-fifths course. To be preceded by subjects B 1 (Physics) and F 1 (General Chemistry).

The course includes a discussion of methods of manufacture of the more important materials (except such information as comes within the province of the course in Metallurgy); forms in which these materials appear in the market; their adaptation to the purposes of the engineer; methods of preserving materials from corrosion and decay; etc. South Kensington Notes on Building Construction, Vol. III. The course is supplemented with practical work in testing, for details of which see subject M 6 (Testing Materials of Engineering).

M 2.—*Shop Practice.*

MR. WASS AND MR. SHIELDS.

Forty-five hours per week, eleven weeks. To count as two full courses. To be preceded by subjects L 1 (Mechanical Drawing) and

M 1 (Properties of Materials), except in case of pupils who enter for this course alone.

The classes meet every week day, Saturday excepted, and work nine hours per day, including lectures and practical work. The entire shop practice is to be taken as a whole and no credit can be given for the completion of any part of it alone.

Instruction.—The instruction is largely personal, and each student is advanced according to his proficiency, irrespective of the progress made by other members of the class. In the Machine Shop, practice is given in chipping, filing, scraping, general vise work, pipe fitting, and use of machine tools. In the Pattern Shop, a course in bench work, making joints, turning, etc., precedes actual practice in pattern making. To familiarize the student with the use of actual working drawings, nearly all work done in both shops is to blue prints made in the drawing room. In order that the students may learn real shop methods, as used at the present day, the instructors who assist the professor in charge are men who have had a number of years' practical experience in the work they are expected to teach here.

The instruction here followed is calculated to teach the student, from the very start, the necessity of close and accurate work. Each man, as soon as he has had a little preliminary practice, is put on some piece of work *intended for actual use*, and held responsible for the results. This plan is here considered superior to the others in common use, whereby the work is confined to practice pieces which end up in the scrap pile. No man will take extra care in fitting such pieces, nor does a student regard it as a matter of any consequence whether the work is got out to exact size or not, if it is to be thrown away in the end.

To familiarize the student with the operation and care of machinery, each one will be detailed from time to time to fire the boiler, run the engine, clean and oil the machinery, and to perform such other duties of this nature as the instructor in charge may assign him.

All work done in the shops is considered as the property of the school. No student is allowed to take up any work not assigned to him by the instructor.

Shop Equipment.—The equipment of the shops has been carefully selected. The machine shop contains in addition to the necessary work benches, a 24-inch by 16-foot New Haven Tool Co.'s engine lathe with power cross-feed and compound rest, a 12-inch by 5-foot Prentice engine lathe, a 14-inch by 6-foot Lodge and Davis engine lathe with power cross-feed, a 13-inch by 5-foot Putnam engine lathe, two hand lathes, a 34-inch automatic feed Blaisdell drill press, a 20-inch Lodge and Davis drill press, a 16-inch Gould and Eberhardt shaper, a 10-inch Boynton and Plummer traverse head shaper, a Whitcomb planer, of capacity 8x2x2 feet, a 20x20-inch x 4-foot planer, by Wm. Sellers & Co., a Brainard No. 4 Universal milling machine, one wet and two dry emery grinders, a challenge buffer, a Q. and C. power hack saw, and several smaller machine tools.

The assortment of chucks, taps, drills, reamers and general tools is very complete. For practice in pipe fitting a separate bench has been provided; a complete set of pipe tools, and a supply of pipe and fittings up to two inches inclusive are in stock.

The pattern shop contains two Clement wood lathes, one Reed wood lathe, three wood lathes built in the shops, a pattern maker's lathe to swing five feet, a 33-inch Fay band saw, Beach jig saw, emery wheels and grindstones, Pedrick and Ayer gouge grinder, steam glue heaters, a very complete assortment of hand tools and appliances, and the necessary work benches and vises.

Each student, in each shop, has a separate work bench, set of hand tools, and locker, for which he will be held responsible. Any damage to tools, or other part of the equipment, beyond wear and tear by legitimate use, is charged to the student accountable for it, and must be paid for at once.

Each shop has its own separate tool room, in which the check system of accounting for tools is used, thus familiarizing the student with its operation by actual practice.

Power for the shops is furnished by an 8 x 24 Reynolds Corliss engine, taking steam from the Stirling boiler. Both shops are lighted with electricity, the current being obtained from the school plant, or from the mains of the local Electric Co., when the school dynamos are not in operation.

Charges.—There are no tuition charges, but each student is required to purchase one machinist's hammer, all hand files, emery cloth, a two-foot boxwood rule, waste, and to pay for stock used whenever any work has been spoiled through neglect to obey the orders of the instructor.

Engineering Hall.—The work shops, mechanical laboratories, electrical engineering laboratories, and draughting room, are now located in Engineering Hall, a new building especially designed for shop and laboratory purposes. It is fully equipped with lavatories, lockers, and everything necessary for the students' convenience and comfort when at work. It is lighted throughout with electricity.

Special Students.—Those who desire to take shop work only, and devote all their time to it, are admitted as special students on the following conditions. No student shall be less than 17 years of age. Students between the age of seventeen and twenty must present evidence of having spent at least two years in some reputable high school or academy. Persons 20 years of age or over may be admitted as special students, without having attended a high school, provided they give evidence of being able to follow the work with profit. Those desiring admission as special students should apply directly to Professor Kidwell, and at the earliest possible date, so that due provision can be made for them. Special students have to make the regular $25.00 deposit, the return of which is subject to the following regulations: *No person will be admitted as a special student in shopwork, except with the distinct understanding that in addition to being subject to all the general regulations of the school, he must be in attendance up to the close of the course, otherwise his $25.00 deposit shall be forfeited. Students who are suspended or expelled are included in this rule.* Those who take the entire course will be allowed to withdraw their deposit when the shop work is completed. The course is free to all who are qualified to take it, and in pursuance of its general policy the Mining School is glad to admit, and assist all who are competent, and seriously determined to avail themselves of its advantages; those who fail to apply themselves diligently to the work, and who show that their presence here is of no advantage to themselves, or injurious to others, will be promptly excluded from the course.

Such a special course cannot be credited to any student who later on decides to work for a degree, unless courses L 1 (Mechanical Drawing) and M 1 (Properties of Materials) preceded the shop work.

M 3.—*Mechanism.*

MR. MOORE.

Laws of motion, linkwork, cams, teeth of wheels, wheels in trains, aggregate motion, miscellaneous problems in applied mechanics. Goodeve's Elements of Mechanism. Three times a week, fourteen weeks. To count as a two-fifths course. To be preceded by subjects C 1 (Analytic Mechanics) and L 1 (Mechanical Drawing), and preceded by, or accompanied with, subject C 2 (Analytic Mechanics).

M 4.—*Mechanics of Materials.*

MR. MOORE.

Application of the principles of statics to rigid bodies; elasticity and resistance of materials; cantilevers; simple, restrained and continuous beams; bodies of uniform strength; riveting; torsion of shafts; combined stresses; resilience; apparent and true stresses, computation of proper sizes and proportions of beams, columns, shafts, flat plates, etc. Merriman's Mechanics of Materials. Three times a week, thirty-four weeks. To count as one full course. To be preceded by subject M 1 (Properties of Materials) and preceded by, or accompanied with, C 2 (Analytic Mechanics).

M 5.—*Mechanical Engineering.*

MR. MOORE.

Three times a week, thirty-four weeks. To count for a full course. The instruction is divided as follows:

(a) The STEAM ENGINE.—Description of the various styles and types of engines, such as ordinary slide valve, Corliss, Westinghouse, Willans, etc.; description of compound, triple, and quadruple expansion engines. General arrangement of parts, and discussion of various engine details, such as cylinders, piston and rods; stuffing boxes, cross heads, cranks and crank shafts, etc. Elementary course, leading up to subjects L 6 (Machine Designs), M 7 (Valve Gears) and M 8 (Thermodynamics). Text-book used: Whitham's Constructive Steam Engineering, together with manufacturer's trade circulars. Three hours a week, five weeks.

(b) STEAM BOILERS. Fuel and combustion; representative types of boilers, with description and discussion of leading exponents of each type: proportions of boilers, heating surface, grate surface, tube area, strength of shell heads, stays, etc.; boiler details, grate bars, mechanical stokers, settings, breechings, chimneys, etc. Leads up to subject L 6 (Machine Design). Whitham's Constructive Steam

Engineering, together with lectures. Three hours a week, thirteen weeks.

(c) ENGINEERING APPLIANCES. Steam gauges; lubricators; safety valves; reducing valves; steam traps; feed heaters and purifiers; steam separators; grease extractors; damper regulators; surface, jet, and ejector condensors; steam pipe and fittings; boiler and pipe coverings; etc. Taught principally from manufacturer's catalogues. Three hours a week five weeks.

(d) PUMPS AND PUMPING MACHINERY. Discussion of pump details such as pistons; plungers, and methods of packing them; size of suction and delivery pipes, air and vacuum chambers, etc. Types of pump, hydraulic, force pump, crank and fly wheel, direct acting, duplex, compound and triple expansion pumps. Fire, mine, rotary, centrifugal, and high duty pumps. Duty trials of pumps. Barr's Pumping Machinery, and Whitham's Constructive Steam Engineering. Three hours a week, eleven weeks.

Subject M 5 must be taken as a whole, and counts as one full course. To be preceded by subjects L 1 (Mechanical Drawing) and M 2 (Shop Practice), and preceded by or accompanied with subjects M 3 (Mechanism) and M 4 (Mechanics of Materials).

M 6.—*Testing Materials of Engineering.*

PROFESSOR KIDWELL AND MR. MOORE.

Tensile, compressive, transverse, torsional, and impact tests of metals and timber. Tensile tests of cordage, and iron and steel wire rope. Transverse, compressive, and absorption tests of stone and brick. Tensile, compressive, cross breaking, and specific gravity tests of cement, also tests for fineness, time of setting, and constancy of volume. Tests of lubricating oils, including density, viscosity, fire test, cold test, wearing qualities and coefficient of friction under various speeds and loads on journal. Lectures and mimeographed notes. Forty-five hours a week, or five hours class room and thirty hours laboratory work a week, five weeks. To count as a full course. To be preceded by subject M 4 (Mechanics of Materials).

Laboratory for Testing of Materials.—The equipment of this laboratory is as follows: One 100,000 lb. Riehlé Machine, fitted for making tensile, compressive, cross breaking, and shearing tests, (special appliances have also been provided to enable this machine to make shearing tests on wood, and transverse tests on specimens up to nine feet in length); an autographic torsional testing machine, an Ashcroft oil tester driven by a separate electromotor, a 2,000 lb. Olsen cement testing machine, with tools for tensile, compressive and transverse tests; a Henning electro-contact micrometer for measurement of extension, an Olsen electric-contact compression micrometer; a deflectometer, a Brown and Sharp Vernier caliper, and several screw micrometers; two Troemner balances, viscosometers, etc.

Those having materials to be tested should make application to the professor in charge of the department, and make definite arrangements with him for the precise work they desire to have done.

M 7.—*Valve Gears.*

PROFESSOR KIDWELL.

Kinematics of the plain slide valve, link motions, double valve gears, radial and drop cut-off gears. Peabody's Valve Gears for the Steam Engine. Twice a week, twenty-six weeks. To count as a one-half course. Must be preceded by subject M 5 (Mechanical Engineering) and accompanied with subject L 6 (Machine Design).

M 8.—*Thermodynamics.*

PROFESSOR KIDWELL.

Its application to steam, gas and air engines; air compressors, rock drills, and refrigerating machines. Tabulation and discussion of steam engine and boiler tests. Peabody's Thermodynamics of the Steam Engine. Twice a week, twenty-six weeks, to count as one-half a course. To be preceded by subject M 5 (Mechanical Engineering.)

M 9.—*Mechanical Engineering: Laboratory Practice.*

PROFESSOR KIDWELL AND ASSISTANTS.

Experimental work in the Mechanical Laboratory; determination of heating value of fuels; quality of steam; use of steam engine indicator, Prony brake, and other dynamometers; standardizing of indicators, steam gauges, etc.; complete tests of engines, boilers and pumps. Peabody's Thermodynamics of the Steam Engine, Barr's Pumping Machinery, and mimeographed notes and forms. Five hours recitation and thirty hours laboratory work per week, eleven weeks. To count as two full courses. Must be preceded by subjects

L 6 (Machine Design), M 7 (Valve Gears) and M 8 (Thermodynamics).

This course is intended to give the student ample opportunity to verify practically the principles laid down in the preceding courses. Each student will be required to set up his own apparatus, and in many cases to design and build appliances for any special work on hand.

Equipment.—The power plant contains one 58 H. P. Stirling water-tube boiler, two 40 H. P. steel return tubular boilers, one 8x24 Reynolds Corliss Engine in shops, an 8x12 Buckeye engine in dynamo room, a 9x9 N. Y. safety vertical slide valve engine in the stamp mill, a 5x5 horizontal slide valve engine in laboratory for testing materials, and one 50 H. P. Wheeler surface condenser, with Worthington air and circulating pump. Of the minor apparatus there is now in stock one Tabor indicator, one Crosby indicator, one Hine and Robertson indicator, eight polar planimeters, ten of Greene's standard thermometers for calorimetric work, calorimeters of the following kinds—barrel, continuous, superheating, throttling, and separator,—Heath's stop-watch speed counter, Tabor speed counter, Schaeffer and Bundenburg tachometer, lazy tongs, Hine and Robertson reducing motion, draught gauges, Ashcroft boiler test pump and gauge, gauges for use with water or steam, one Shaw's standard mercurial column gauge tester, one gauge tester of the Ashcroft pattern, with cylinder and plunger made by Pratt and Whitney, Ashcroft pyrometer, Bristol recording gauge, one Hancock ejector, a number of working injectors, with cut models of same, Buffalo scales of several patterns, Worthington water meter; Worthington, Davidson and Prescott pumps, Prony brakes, 8¼-inch Leffel turbine, 23 H P Van Duzen gas engine, Deane and Marsh pumps cut to show the interior mechanism, parts of various sectional boilers, etc.

For further subjects belonging to the department of Mechanical Engineering, see

L 1. Mechanical Drawing.

L 6. Machine Design.

N. ELECTRICAL ENGINEERING.

PROFESSOR KIDWELL.

The use of electricity in mining, as an illuminant; a motive power for hauling, pumping, and operating portable machinery; and as a means of economically transmitting power over long distances, requires of the mining engineer a working knowledge of Electrical Engineering, and to meet this requirement the Mining School at an early date introduced a course in Electrical Engineering. The course is limited to electric light and power work, and does not include telegraphy and telephony.

The instruction is made as comprehensive as the time available will permit, and special care is taken to familiarize the student with the fundamental principles of the subject. In no department of science is this more necessary than in electrical engineering, if the object of the course is to fit the student to be an *engineer*, rather than to spend his time wholly on applications whose details are continually changing, and thereby in the end give him only a smattering of the subject, and prepare him to be a mere starter and stopper. Sufficient ground is covered to enable the student to understand the electrical machinery, appliances, and processes in general use, but in all the work the idea kept steadily in view is to give him a solid foundation for advanced work, should he desire to devote himself particularly to Electrical Engineering after graduation. Details of the courses are as follows:

N 1.—*Electrical Engineering.*

PROFESSOR KIDWELL.

Electrical instruments and measurements considered from an engineering standpoint; accumulators and storage of electrical energy; the arc and incandescent lamps; photometry; methods of wiring, and wiring calculations; electrical fittings; etc. Introductory course, designed to give the student some acquaintance with the practical side of electrical engineering, and thereby prepare him to grasp fully the bearings of the mathematical course in subject N 2 (Electricity and Magnetism). Slingo and Brooker's Electrical Engineering, and Badt's Incandescent Wiring Handbook. Three hours a week, twenty-six weeks. To count as a four-fifths course. To be preceded by or accompanied with subjects B 3 (Electrical Measurements), C 2 (Analytic Mechanics) and M 5 (Mechanical Engineering).

N 2.—*Electricity and Magnetism.*

PROFESSOR KIDWELL.

Mathematical Discussion of the fundamental principles of electricity and magnetism, embracing potential, electrostatics, capacity magnetism, steady currents, variable currents, alternating currents, and electrical units. Nipher's Electricity and Magnetism. Three hours per week, twenty-six weeks. To count as a four-fifths course. Must be preceded by subjects B 3 (Electrical Measurements) and N 1 (Electrical Engineering). This course is intended to teach the principles which lie at the bottom of the science of Electricity, and which must be thoroughly mastered by the student if he is to obtain other than a superficial knowledge of the subject. It is to be taken in connection with subject N 3 (Electrical Engineering).

N 3.—*Electrical Engineering.*

PROFESSOR KIDWELL.

Practical application of principles laid down in the preceding course, covering the dynamo, for direct and alternating currents; motors, and their adoption to various duties and conditions; static and motor transformers; electric meters; switchboard work; transmission of electrical energy. Slingo and Brooker's Electrical Engineering, Nipher's Electricity and Magnetism, and Snell's Electric Motive Power. Twice a week, twenty-six weeks. To count as one-half a course. To be preceded by subjects B 1 (Electrical Measurements) and accompanied with subject N 2 (Electricity and Magnetism).

N 4.—*Electrical Engineering—Laboratory Practice.*

PROFESSOR KIDWELL AND ASSISTANTS.

Practical work in the Electrical Engineering laboratory. Testing of dynamos, motors, transformers, meters, etc. Photometric tests of arc and incandescent lamps. Testing of electrical engineering apparatus and materials. Forty-five hours a week, or five hours lecture work, thirty hours laboratory a week, eleven weeks. To count as two full courses. To be preceded by subjects N 2 (Electricity and Magnetism) and N 3 (Electrical Engineering). (Subject N 4 will not be given in 1897-98).

Equipment.—In the new engineering building now erected an

Electrical Laboratory has been provided for, and it will be thoroughly equipped with the machinery and apparatus necessary to give the student a practical knowledge of the principles taught in the class room. The equipment will include incandescent dynamos, both direct and alternating current, and an arc light machine, with complete switch boards, current, and pressure indicators, regulators, transformers, etc.

The dynamos will be driven by a separate Buckeye 8x12 automatic engine.

At present writing, this equipment has not been completed. The Buckeye engine, and line shafting, etc., for the dynamo room, are in place. There are on hand one No. 4 Edison dynamo, with all switchboard instruments, a 5 H. P. Excelsior constant current motor, one 2 H. P. Sprague motor, one T. H. recording meter, several Ayrton and Perry ammeters and voltmeters, German silver and iron wire resistance frames, etc. During the past year the laboratory has through the liberality of Hon. J. M. Longyear of Marquette, been further provided with one 200 light National compound wound dynamo; one 23 H. P. Van Duzen gas engine, and a battery of fifty-six Bradbury-Stone storage cells, together with all switchboard instruments necessary for operating them. The remainder of the equipment will be provided as soon as an appropriation therefor has been made by the legislature. Until this equipment is provided, subject N 4 (Electrical Engineering—Laboratory Practice) will not be given.

Q. CIVIL ENGINEERING.

PROFESSOR SPERR AND MR. HOULE.

Q 1.—*Surveying, Theory and Practice.*

PROFESSOR SPERR AND MR. HOULE.

Summer term, forty-five hours a week for eleven weeks. To count for two full courses.

During eleven weeks of each summer term a course of surveying is conducted. The object of this course is two-fold:

First, to give the regular students more thorough and extended practice in the field than it is possible to do when they are attending to other school work. Second, to provide a thorough, practical course in Surveying for persons, other than regular students, who may be desirous of becoming surveyors, or who may wish to obtain practical experience in the subject. There is perhaps no course of study which can be offered by an institution, that will give such quick and profitable returns for the money and time expended by the student, as a thorough, practical course in Surveying, since employment at a fair salary can almost always be obtained by a competent surveyor.

Study and practical work are combined in this course.

Johnson's Theory and Practice in Surveying, edition of 1895, and Searle's Field Engineering are used as text-books.

One or more hours of each working day will be taken for lecture and recitation work, while the remainder of the time will be given to field practice. The course treats for the most part of the adjustment of instruments and practice in typical kinds of surveying work ordinarily required to be done by, or under the supervision of, a civil or mining engineer.

The vicinity of the school affords opportunity for laying out this work as may be required for a large mining enterprise. A certain mining location is taken as a base for operations, and the work is laid out as follows:

1. A preliminary topographical map is made by means of pacing and the hand level.
2. A survey is made of the location with chain and sight poles.
3. The farms are surveyed with solar compass and chain.
4. A meridian line is established by observations on Polaris.
5. A town site is laid out with transit and steel tape.
6. An azimuth traverse is run around an adjoining piece of land with transit and stadia.
7. Lines of leveling are run from Portage Lake to establish permanent bench-marks upon the location.
8. An adjoining section of land is retraced and sub-divided according to United States Land Office regulations.
9. The mines are considered as claims under the United States laws governing mineral lands, and surveys for patents are made according to government regulations.
10. A base line is measured for a system of triangulation connecting points on the opposite shores of Portage Lake.
11. Signals are erected and the angles of the triangulation system are measured with the transit,

12. A topographical survey is made of the included area with the transit and stadia.

13. A topographical survey of a certain area is made with the plane table.

14. A line of railroad two or three miles in length, is surveyed from the mines to some point on the Lake. This survey includes (1) a preliminary survey with compass, chain, hand level and Y level; (2) permanent location with transit, steel tape and Y level; (3) establishment of grade line on profile sheet; (4) cross-section leveling; (5) computations of excavations and embankments from cross-section sheets; (6) location of bridge abutments and piers; (7) laying in frogs and switches.

The class is divided into squads, each kind of work being divided and apportioned to the different squads. Each member of a squad is required to make a full set of notes of the work done, and to carry out the computations. From these notes maps are made in the second course in Topographical Drawing (L 3). Facilities are given, however, to students who wish to do mapping work during the summer, if they are prepared to do so and can find the time.

The equipment for instruction comprises the following set of instruments: One plane table from Buff and Berger; nine transits,—three from Buff and Berger, three from Heller and Brightly, two from Fauth, one from Gurley; five Burt solar compasses; five magnetic compasses; six Wye levels, one from Buff and Berger, three from Heller and Brightly, and two from Gurley; fifteen Locke hand levels. In addition to these more expensive instruments, the school owns the necessary number of chains, steel tapes, poles, rods, etc.

Persons who wish to attend this summer course only, are required to prepare themselves upon the subjects of Plane Trigonometry, Logarithms, and Mensuration. They are to provide themselves with the text-books used, a 25 ft steel pocket tape graduated to feet and tenths, and 5½ inch dividers, brass protractors, right line pen, decimal scale, T square, 8-inch triangle, thumb tacks, India ink, red ink, pencils and erasers, and drawing board, such as are required in Topographical Drawing.

The furnishing of the Surveying apparatus by the Mining School is a heavy expense to the institution, and while losses due to ordinary and legitimate wear and tear of the instruments are borne by the school, any injuries due to carelessness on the part of the student must be made good by him.

The summer course in Surveying will commence each year about the first of June, and all persons who desire to attend are requested to send in their names early to Professor Sperr or to the Director of the Mining School, in order that proper provision may be made for them. This course, like all others in the school, is free to anyone who is properly qualified, whether a resident of the State of Michigan or not. The course is given in Houghton.

Regular students, in order to take this course, must have passed in subjects A 3 (Spherical Trigonometry) and L 2 (Topographical Drawing).

Q 2.—*Hydraulics.*

PROFESSOR SPERR.

Merriman's Treatise on Hydraulics is used as a text-book and the subject is studied with special reference to its applications in mining, milling and metallurgical operations.

The subjects required to precede this are A 5 (Calculus), B 1 (Physics), C 1 (Analytic Mechanics), and R 1 (Principles of Mining), and preceded by, or accompanied with, subject C 2 (Analytic Mechanics).

For further work in the department of Civil Engineering, see

L 2. Topographical Drawing.
L 3. Topographical Drawing (Mapping).
L 4. Graphical Statics.
L 5. Engineering Design and Construction.

R. MINING ENGINEERING.

PROFESSOR SPEER AND MR. HOULE.

R 1.—*Principles of Mining.*

PROFESSOR SPERR.

This course is designed to cover the elementary principles of mining under the following general topics:

(1) Fluid Mining: Oil. Gas. Salt.

(2) Gravel Mining (Placer): River Mining. Drift Mining. Hydraulic Mining. "Dry Washing." Beach Mining.

(3) Ore Mining.

(4) Coal Mining.

(5) Rock Mining (Quarrying).

This year Ore and Stone Mining by C. LeNeve Foster, is used as a text-book. On Wednesdays trips are made into the copper mines. These excursions are helpful to the student in enabling him to understand the nature of ore deposits and to comprehend the discussion of the various mining operations as applied to different kinds of mining.

This subject is required to be preceded by subject Y 1 (Principles of Geology); and to be taken by all candidates for the S. B. or E. M. degree.

R 2.—*Mine Surveying and Mining.*

PROFESSOR SPERR AND MR. HOULE.

Two hours a week for twenty weeks. To count for two-fifths of a course.

The classroom work in these subjects is divided into two parts: First: Mine Surveying. Second: Mining.

First: Surveying. This comprises the

(1) The adjustment and use of instruments employed in Mine Surveying.
(2) The methods of surveying the surface location.
(3) The connection of the surface survey with the underground workings.
    (a) By adit level.
    (b) By stope.
    (c) By vertical shaft.
    (d) By inclined shaft.
(4) Methods employed in surveying the various kinds of underground workings.

Full sets of notes of Mine Surveys are given to the students, which are employed by them in making maps as they would do in actual practice.

Second: Mining.

(1) The laying out of different kinds of mines to obtain
    (a) The maximum output.
    (b) The greatest economy.
    (c) All the mineral.

The instruction is given from private notes and from references to professional papers to be found in the Mining School library. To be preceded by L 3 (Topographical Drawing), Q 1 (Surveying), R 1 (Principles of Mining) and Y 1 (Principles of Geology).

R 3.—*Mine Surveying and Mining: Practical Work.*

PROFESSOR SPERR AND MR. HOULE.

Forty-five hours a week for six weeks. To count as a full course. The first three weeks are devoted to surveying and mapping a mine or some portion thereof, either in the "Copper Country" or in some one of the iron mining districts of Northern Michigan. The last three weeks are devoted to the examination of mining methods in the iron ore mines. Sketches are made (a), of the plans of the mines to show methods of laying out; (b), of cross-sections to show methods of stoping; (c), of timbers to show methods of framing; (d), of the timbers set up in drifts and stopes; (e), of the tramming, hoisting and general handling arrangements; (f), of ore schutes, ore pockets, etc.

This work must be preceded by subject R 2 (Theoretical Mine Surveying and Mining) except for students who enter for this subject alone, who are required to be prepared in Algebra, Trigonometry, and in the use of the transit and level.

R 4.—*Mining Engineering.*

PROFESSOR SPERR.

The instruction covers the theoretical study of laying out, designing, and equipping surface and underground works, employed in placer mining, and in gold, silver, copper, lead, zinc, tin, coal, iron and diamond mines.

Three times a week, twenty weeks. To count as three-fifths of a course, to be preceded by subjects, C 2 (Analytic Mechanics), M 3 (Mechanism) and Q 2 (Hydraulics). (Subject R 4 will not be given in 1896–1897.)

R 5.—*Mine Management and Accounts.*

PROFESSOR SPERR.

This course is designed for the study of the relations of employer and employé; the nature of contracts, leases, etc.; the questions relating to contract work, work on company account, and tribute work.

The student, having an elementary training in book-keeping, is required to make out pay rolls and other auxiliary books especially adapted to mining operations; make out cost sheets and reports to officials and stockholders.

This subject is to be preceded by subjects R 1 (Principles of Mining), and R 3 (Mine Surveying and Mining).

R 6.—*Mechanical Ventilation of Mines.*

PROFESSOR SPERR.

This subject is given to afford an opportunity for the discussion of Mechanical Ventilators to those who may wish to acquire a working knowledge of the subject and who are prepared to understand the theoretical principles involved. The general principles of Ventilation are given in courses R 1 (Principles of Mining), R 2 (Mine Surveying and Mining), and R 4 (Mining Engineering) and these subjects, with M 5 (Mechanical Engineering) and Q 2 (Hydraulics), are required to precede subject R 6.

(This subject will not be given in 1896-1897).

S. ORE DRESSING.

PROFESSOR SPERR AND MR. BURRALL.

S 1.—*Ore Dressing—Theory and Practice.*

PROFESSOR SPERR AND MR. BURRALL.

Forty-five hours a week, five weeks. Summer term. To count for a full course.

Most of the time is given to practical work in the stamp mill, taking a certain time each day for instruction in the theoretical principles involved in the operations.

The students do all the work in the mill, and each student is given an opportunity to become familiar with all the different kinds of work.

The students are required to take samples and ascertain by fire assay the degree of efficiency of the dressing operations which they are conducting.

Each student is required to spend some time each day in reading technical literature upon the subject, which is to be found in the library and to which references are given.

This subject is to be preceded by G 1(Assaying), M 2 (Shop Practice), Q 2 (Hydraulics), and W 2 (Mineralogy).

V. BIOLOGY.

THE DIRECTOR, ASSISTANT PROFESSOR SEAMAN AND MR. SUTTON.

V 1.—*Botany, General and Economic.*

THE DIRECTOR.

First eight weeks of the fall term, three times a week. To count for one-fifth of a course.

Instruction in this subject is given by lectures with recitations upon the same. It is intended in these lectures to give a brief review of Botanical Classification, Fossil Botany and the special characters of plants, important economically, and their various uses. The object is to give the student such information about woods and other useful plants, and fossils, as he needs for subsequent work in Engineering, Paleontology and Geology. (This subject will not be given in the year 1896–1897.)

V 2.—*Zoology and Palæontology.*

ASSISTANT PROFESSOR SEAMAN AMD MR. SUTTON.

Fall term, nine hours a week, fourteen weeks. To count for two-fifths of a course.

An elementary course is given in these subjects in order that the students may better understand their later work in Geology.

As these subjects have been united in one course, the Zoology will be given more as a preface to the Palæontology, than as a full description of the various forms of animal life. The classes of animals whose structure is such that they are seldom, or never preserved as fossils will be mentioned but incidentally; while those classes, which, on account of their hard parts, yield common and characteristic fossils, will be described more in detail. In the Palæontology, will be considered the various means by which organisms are preserved, their manner of entombment, their habitat, zonal and areal distribution, etc.

It will be the aim of this course to train the student to close and accurate observation, and special care will be taken to point out those characters by which fossils may be recognized and determined. The student will be required to determine about one hundred genera which have been specially selected to cover the entire geological column. There is a working collection of nearly three thousand specimens. These will be used to drill the students in determining fossils in various states of preservation, and in assigning them to their proper class, order, or genera according to the perfection of the specimens. The specimens are arranged unlabeled in drawers and pains will be taken to train the eye to recognize resemblances and differences. Besides the working collection there is a small type collection, of living and fossil forms, arranged zoologically in accordance with Nicholson's New Manual of Palæontology, and a larger one of fossils containing over one thousand specimens arranged both zoologically, and according to geological horizons.

Wood's Elementary Palæontology, supplemented with lecture notes will be used as a laboratory guide.

W. MINERALOGY.

W 1.—*Crystallography.*

ASSISTANT PROFESSOR SEAMAN AND MR. SUTTON.

Nine hours a week for the first eight weeks of the Fall term.

To count for one-fifth of a course.

The instruction is given by means of lecture notes and laboratory practice in determining the crystal forms on wooden models and natural crystals.

As the student's future work in Mineralogy largely depends upon his knowledge of this subject, he is required to familiarize himself with the principles which it involves.

The law of symmetry is explained somewhat in detail, thus enabling the student to comprehend the derivation of hemihedral and tetartohedral forms, as well as to better understand those forms that are holohedral. The formation of crystal aggregates are briefly considered, and the more common laws of twinning are explained and illustrated with models and natural crystals.

Cleavage is shown to conform with the law of symmetry, and the student is drilled in determining the crystal system, and symmetry of cleavage fragments.

The laboratory is provided with a working collection of two thousand one hundred and fifty wooden models, and two thousand two hundred natural crystals representing more than one hundred different mineral species.

Besides the above there are one hundred and fifty glass models for illustrative purposes.

W 1.—MINERALOGY.

ASSISTANT PROFESSOR SEAMAN AND MR. SUTTON.

Fall and winter terms, twelve hours a week for twenty-eight weeks. To count as a full course. The work in Determinative Mineralogy is preceded by the course in Crystallography and by instruction in Physical Mineralogy, although part of the instruction in these subjects is given as needed in connection with the Descriptive Mineralogy.

For Determinative Mineralogy there is provided a typical set of all the important minerals, special attention being paid to those of economic value, as well as to those occurring as gangue, or rock-forming minerals. Special collections are arranged showing the physical characters of minerals, their pseudomorphs, etc.

These minerals are in drawers, labeled, and are at all times freely accessible to the student.

Besides the typical collection of minerals, there are placed in other drawers a large number of specimens of the same mineral species. These are arranged in convenient groups, but are unlabeled. These specimens are selected so as to represent as great a variety of form, appearance and locality as possible, in order that the student may be familiar with all the types that he will be likely to meet in his professional practice. Numerous drawers of these unlabeled minerals are assigned to each student, who is to determine them and to recite upon them, not in a class, but singly with the instructor. He is required to do that which the practical mineralogist does; to determine his minerals by the shortest method possible, consistent with accuracy; the method to vary according to the specimen. To this end every method of determination short of quantitative analysis is employed; that is, in each case the crystal form and other physical characters are used, as well as the blow-pipe and wet tests, so far as they may be needed.

After the student has studied and recited upon the specimens contained in a sufficient number of drawers of one group, he is assigned to drawers containing the unlabeled minerals of another group, which have mixed with them specimens of the preceding group or groups. In this way each student is required to determine in his course from 3,000 to 6,000 different mineral specimens, belonging to the 287 selected species.

The instruction is based on the sixth edition of Professor James D.

Dana's System of Mineralogy, revised by Professor Edward S. Dana, 1892, and every student is expected to provide himself with a copy.

In addition, or supplementary to this work, there is given a series of lectures and notes prepared by the Director for use in his classes in 1876, and revised and enlarged from time to time since. In these notes the characteristic features of each mineral, its uses, and the practical methods employed to distinguish each one, are pointed out. Especial attention is given to the methods needed in the field and mine, where one cannot have recourse to a chemical laboratory. Every effort is made to train the student to close, accurate observation, to reason correctly upon what he sees, and to exercise good judgment in his decisions.

The result of this work is such that a student not only knows how to proceed, in order to determine any mineral that he may meet, but he is also enabled to recognize at sight, or by simple tests, the great majority of specimens belonging to the two hundred and eighty-seven mineral species that he is required to study in his course.

During the summer of 1892 the entire mineral collection was re-arranged to correspond to the sixth edition of Dana's System of Mineralogy, with the exception of such modifications in classification, as the Director thought would enable the student to do his determinative work in an easier and better way. (See Tables IV-X).

For purposes of instruction in this subject the laboratory is supplied with the following collections:

Crystal Models in Glass			151	
Crystal Models in Wood and Plaster			2,153	
Natural Crystals			2,260	
Collections illustrating Physical Properties, Pseudomorphs, Optical Properties, etc			485	
Lecture Collection of Minerals			10,000	
Practice Collection of Minerals.	First Series	2,500		
	Second Series	2,100		
	Third Series	1,275		
	Fourth Series	3,225		
	Fifth Series	1,525		
	Sixth Series	1,850		
	Seventh Series	1,425		
	Review Series	3,125		
			17,025	
				32,074

In order that the special mineralogical work done in this institution may be better understood by persons seeking information upon this point, and in addition to serve as a guide to the pupil in referring to the lecture specimens, the appended tables IV-X., prepared by the Director, with the aid of Professor Seaman, are given of the species to be studied in the laboratory work in this course as well as to show the classification followed. The system of numbering for the original or lecture collection numbers is to increase by ten each time, in order to allow of interpolations of new specimens without having to re-number those already in the lecture collection.

The tables show only the numbers of the specimens belonging to the species upon which laboratory work is given, and not those of the other species represented in the mineral collections.

This subject is to be preceded by B 1 (Physics), F 1 (General Chemistry), F 2 (Blowpipe Analysis) and W 1 (Crystallography).

X. PETROGRAPHY.

THE DIRECTOR AND MR. SUTTON.

XI.—*Petrography: Lithology and Petrology.*

THE DIRECTOR AND MR. SUTTON.

Fall and winter terms, twelve hours a week for twenty-eight weeks. To count for a full course.

In this subject the student is taught to use the microscope as a simple instrument, and also as a piece of optical apparatus for the determination of minerals and rocks.

The work is divided into three parts: *Microscopic Mineralogy, Lithology, and Petrology.*

A. *Microscopic (Optical) Mineralogy:* Under this head is treated the various optical and other characters of minerals as revealed by the microscope. Their alterations are especially studied owing to the importance of these in the subjects of Economic Geology and Lithology.

The lectures given by the Director are chiefly devoted to the description and use of the microscope as a simple instrument and as a piece of optical apparatus for the determination of minerals and rocks. This part of the work will comprise its use in common and in polarized light, both as a microscope, and as a polariscope; the chemical properties of minerals as determined under the microscope;

and the general description of the distinguishing characters of the important rock forming minerals.

These lectures are intended to give a clear and suitable introduction to the subject of Microscopic and Optical Mineralogy, that shall be adapted to the needs of the Geologist, the Civil and Mining Engineer, Chemist, Metallurgist, Teacher, Architect, and others who may need a good working or practical knowledge of the subject.

The lectures on Optical and Microscopic Mineralogy in general cover the following ground:

I. APPARATUS.

(a) Simple Microscope or Lens.

(b) Compound Microscope..
- Base or Foot.
- Arm.
- Body..
  - Simple.
  - Binocular.
- Objectives..
  - Dry,
  - Immersion,
    - Resolving Power.
    - Flatness of Field.
    - Penetration.
    - Working Distance.
    - Magnify'g Power.
- Society Screw.
- Adaptor.
- Nose Piece.
- Eye Piece or Ocular..
  - Huygenian,
  - Solid,
  - Periscopic,
    - Flatness of Field.
    - Size of Field.
    - Magnify'g Power.
    - Cross Hairs.
- Draw Tube.
- Collar.
- Coarse Adjustment.
- Fine Adjustment.
- Stage ..
  - Fixed.
  - Revolving.
- Clips.
- Centering Screws.
- Mirror and Bar.
- Sub-stage and Bar.
- Diaphragm.
- Optical Axis.
- Use of Powers.
- Magnifying Power.
- Size of Object.
- Camera Lucida and Drawing.
- Shade.

(c) Accessory Apparatus...
- Table.
- Light.
- Use and Care of the Eyes.
- Slide.
- Cover Glass.
- Iron Plate for Grinding Sections.
- Grinding Machine.
- Cutting Machine

II. Preparation of Materials.

- (a) Preparation of Section
  - Breaking off the Chip.
  - Cutting the Section.
  - Grinding on one Side.
  - Polishing on one Side.
  - Canada or Fir Balsam.
  - Cementing Chip to Glass Plate.
  - Grinding the Second Side.
  - Polishing the Second Side.
  - Transference.
  - Cover Glass.
  - Cleaning Section.
  - Labeling Section.
  - Thinness of Section.

III. Character of Minerals.

- (a) Crystal Form
  - Cleavage Plates.
  - Splinters.
  - Powder.
  - Section.
  - Normal.
  - Abnormal.
- (b) Crystalline Structure.
  - Globulites.
    - Cumulites.
    - Margarites.
    - Longulites.
  - Microlites.
    - Belonite.
    - Trichites.
  - Skeletons.
  - Deformed Crystals.
  - Zonal Forms.
- (c) Mineral Aggregates.
- (d) Corrosion of Crystals.
- (e) Inclusions in Minerals.
  - Gas or Vapor Cavities.
  - Vacuum Cavities.
  - Fluid Inclusions.
    - Bubble.
    - Water.
    - Liquid Carbonic Acid.
    - Saline, etc.
  - Glass Inclusions.
    - Bubbles.
  - Stone Inclusions.
  - Included Minerals.
  - Arrangement of Inclusions.
  - Determination of Inclusions.
- (f) Cleavage.
  - Octahedral.
  - Cubic.
  - Pyramidal.
  - Prismatic.
  - Pinacoidal.
  - Slipping Planes.
  - Pressure Planes,

IV. LIGHT.

- (a) Vibration......
  - Rectilinear.
  - Elliptical.
  - Circular.
- (b) Refraction.
  - Single Refraction, Isotropic,
    - Gas.
    - Fluid.
    - Amorphous Substances.
    - Isometric Minerals.
  - Double Refraction, Anisotropic,
    - Tetragonal, Hexagonal, — Two Indices.
    - Orthorhombic, Monoclinic, Triclinic, — Three Indices.
  - Index of Refraction, Critical Angle.
  - Determination of Index,
    - Comparative Indices.
    - Sorby's Method.
    - Bertin's Method.
    - Total Reflectometer.
- (c) Unmodified or Common Light, Natural colors of the Mineral Plate.
- (d) Polarized Light,
  - Comparison of Properties of Common and Polarized Light.
  - Means of Polarizing Light,
    - Reflecting Plate or Surface.
    - Bundle of Glass Plates.
    - Tourmaline Plate.
    - Nicol Prism.
  - Ordinary and Extraordinary Rays.
  - Plane of Polarization, Longer Nicol Diagonal, Horizontal Cross Hair.
  - Plane of Vibration, Shorter Nicol Diagonal, Vertical Cross Hair.
  - Polarizer.
  - Analyzer.
  - Optic Axes,
    - Uniaxial,
      - Tetragonal.
      - Hexagonal.
    - Biaxial,
      - Orthorhombic.
      - Monoclinic.
      - Triclinic.
    - Bisectrics,
      - Acute.
      - Obtuse.
  - Solids of Elasticity,
    - Sphere.
    - Spheroid.
    - Ellipsoid.
  - Axes of Elasticity,
    - Least.
    - Mean.
    - Greatest.
  - Uniaxial Crystals,
    - Positive.
    - Negative.
  - Biaxial Crystals,
    - Positive.
    - Negative.

- (e) Parallel Polarized Light.
  - Extinction Lines
    - Always Dark,
      - Amorphous.
      - Isometric.
    - Always Parallel,
      - Tetragonal.
      - Hexagonal.
      - Orthorhombic.
    - Usually Oblique,
      - Monoclinic.
    - Always Oblique,
      - Triclinic.
    - Determination of Extinction Lines
      - Crossed Nicols Alone.
      - Calcite Plate.
      - Brezina Plate.
      - Quartz Plate.
      - Calderon's Plate.
      - Bertrand Ocular.
  - Colors and Color Scale.
  - Determination of Axes of Elasticity,
    - Mica Plate.
    - Gypsum Plate.
    - Quartz Wedge.
  - Color with Polarizer only or Pleochroism,
    - Dichroic.
    - Trichroic.
    - Pleochroic Halos.
- (f) Converging Polarized Light.........
  - Sections Must be Cut in Special directions.
  - Converging Lens.
  - Observation of Axial Images,
    - Ocular Removed.
    - Elevation of the Eye.
    - Lens Above the Ocular.
    - Bertrand Lens.
  - Uniaxial Images,
    - Cut Perpendicular,
      - Crossed Nicols.
      - Parallel Nicols.
    - Cut Oblique or Parallel
      - Crossed Nicols.
      - Parallel Nicols.
    - Circular Polarization.
    - Positive or Negative Character
      - Mica Plate.
      - Gypsum Plate.
      - Quartz Wedge.
  - Bixial Images.
    - Cut Perpendicular,
      - Crossed Nicols.
      - Parallel Nicols.
    - Cut Oblique or Parallel,
      - Crossed Nicols.
      - Parallel Nicols.
    - Positive or Negative Character,
      - Mica Plate.
      - Gypsum Plate.
      - Quartz Wedge.
    - Orthorhombic,
      - $r < v$.
      - $r > v$.
    - Monoclinic,
      - Inclined Dispersion.
      - Horizontal Dispersion.
      - Crossed Dispersion.
    - Triclinic.
  - Imperfect Axial Images.

V. Table for Determining the Crystal System of Mineral Plates in Thin Sections Between Crossed Nicols in Parallel and in Convergent Polarized Light.

VI. Mineral Aggregates.

- (a) Aggregate Polarization.
- (b) Structure,
  - Concentric.
  - Radial,
    - Spherulite,
      - Cross.
      - Axiolites.
      - Granospherite.

VII. Specific Gravity.

- (a) Solutions
  - Sonstadt.
  - Klein.
  - Rohrbach.
  - Brauns.
- (b) Apparatus
  - Church.
  - Harada.
  - Thoulet.
  - Brogger.
  - Smeeth.
  - Sollas.
  - Wulfing.
  - Evans.
  - Westphal Balance.
  - Goldschmidt's Scale.
  - Hobbs' Scale.
  - The Derby Pan.

VIII. Microchemical Analysis.

- (a) Methods,
  - Boricky's Method.
  - Streng's Method.
  - Behrens's Method.
- (b) Etching.
- (c) Staining.
- (d) Testing for Aluminium, Calcium, Carbon, Chlorine, Chromium, Cobalt, Copper, Gold, Iron, Lithium, Magnesium, Manganese, Nickel, Potassium, Phosphorus, Silicon, Silver, Sodium, Titanium, etc.

IX. Special Microscopic Characters of Rock Forming Minerals.

(a) *Native Elements:*

Graphite, Iron.

(b) *Sulphides:*

Pyrrhotite, Pyrite.

(c) *Oxides:*

Fluorite, Quartz, Tridymite, Corundum, Hematite, Ilmenite, Perofskite, Spinel, Magnetite, Chromite, Rutile, Zircon, Opal.

(d) *Carbonates:*

Calcite, Dolomite, Magnesite, Aragonite.

(e) *Anhydrous Silicates:*

Orthoclase, Microcline, Plagioclase, Leucite, Enstatite (Bastite), Hypersthene, Pyroxene, Wollastonite Anthophyllite, Amphibole, Glaucophane, Arfvedsonite, Iolite, Nephelite, Cancrinite, Sodalite, Haüynite, Noselite, Garnet, Chrysolite, Scapolite, Melilite, Vesuvianite, Andalusite, Sillimanite, Axinite, Tourmaline, Staurolite, Titanite.

(f) *Hydrous Silicates:*

Prehnite, Analcite, Natrolite, Muscovite (Sericite), Paragonite, Lepidolite, Zinnwaldite, Biotite, Phlogopite, Lepidomelane, Chloritoid, (Ottrelite, Phyllite), Chlorite, Delessite, Serpentine, Talc, Kaolinite, Glauconite.

(g) *Phosphates:*

Monazite, Apatite.

(h) *Sulphates:*

Anhydrite, Gypsum, Alunite.

(i) *Hydrocarbons:*

Carbonaceous Matter.

X. TABLE SHOWING ORDER AND METHODS OF WORK EMPLOYED IN THE STUDY OF ROCKS AND THEIR THIN SECTIONS.

The Director's lectures are supplemented by a special card catalogue which directs the student to the mineral sections, and indicates the plates that he needs to study in order to familiarize himself with the special optical and microscopic characters of minerals. It gives him, in a sufficient number of cases, particular directions how to proceed in his optical work on the selected sections, and informs him what results he may expect to obtain. A card catalogue like this saves a large amount of the time both of student and teacher.

Most of the thin sections of the minerals have been made at the Mining School from the specimens in the Lecture Collection of Minerals, enabling the student to study the microscopic and optical properties in connection with the cabinet specimens from which they were taken.

Besides the lectures there are used as text-books and laboratory manuals, Rosenbusch's Microscopical Physiography of the Rock-Making Minerals, translated by Joseph P. Iddings; Lévy and Lecroix's Tableau des Biréfringences; and Behrens's Manual of Microchemical Analysis.

For the purpose of giving the above elementary, as well as the subsequent graduate, instruction, the department is supplied, amongst other things, with the following apparatus:

Twenty-nine Bausch and Lomb's petrographical microscopes, made expressly for the Michigan Mining School; with micrometer eyepieces, Bertrand's lenses, quartz wedges, undulation plates, etc.

Four Beck's petrographical microscopes with accessories.

One Fuess's largest petrographical microscope, of the latest pattern, with all the accessories; made expressly for this institution.

One Nachet's largest petrographical microscope, with all the accessories.

One Dick's petrographical microscope, with Swift's objectives and other accessories.

One projection microscope.

One Nachet's inverted chemical microscope.

One spectroscope.

One spectropolarizer.

One Sorby's apparatus for observing the four images given by biaxial bodies.

Two Calderon's oculars.

Three Bertrand oculars.

One spectroscope ocular.

One goniometer ocular.

One Babinet's compensator ocular.

One Michel-Levy's comparateur.

One axial angle apparatus for measurements in oil.

One periscope eyepiece.

One Filar micrometer.

One cross-hair micrometer.

Three micrometers.

Four camera lucidas.

Two Abbé's Camera Lucidas.

One Bausch and Lomb's one-inch microphotographic objective.

One mica plate—nose piece.

Many extra eye pieces, objectives, etc.

TABLE V.

SECOND SERIES—FORTY-SEVEN SPECIES.

Deutoxides	Rutile	Zircon		[illegible]	54, 55	II	$(Zr\ Si)\ O^4$.
		Brookite		242, 243	55	IV	$Ti\ O^2$.
		Pyrolusite		243, 244	55, 56	IV	$Mn\ O^2$.
Hydrous Oxides	Opal	Opal	Precious Opal Fire Opal Girasol Common Opal Resin Opal Semi-Opal Hydrophane Cacholong Opal-Agate Menilite Jasp-Opal Wood Opal Hyalite Florite Geyserite Tripolite	194–197	56–58	VII	$Si\ O^2 + H^2\ O$.
	Limonite	Turgite		245	59	VII	$2\ Fe^2\ O^3 + H^2\ O$.
		Diaspore		246, 247	59	IV	$Al^2\ O^3 + H^2\ O$.
		Göthite		247, 248	59, 60	IV	$Fe^2\ O^3 + H^2\ O$.
		Manganite		248, 250	60	IV	$Mn^2\ O^3 + H^2\ O$.
		Limonite	Yellow Ochre Umber Bog Ore Pisolitic Oolitic	250, 251	60–63	VII	$2\ Fe^2\ O^3 + 3\ H^2\ O$.
		Bauxite	Wochenite	251	63	VII	$Al^2\ O^3 + 2\ H^2\ O$.
	Brucite	Brucite	Nemalite	252, 253	63, 64	III	$Mg\ O + H^2\ O$.
		Gibbsite	Hydrargillite	254, 255	64	V	$Al^2\ O^3 + 3\ H^2\ O$.
		Hydrotalcite	Houghite	256	65	III	$6\ Mg\ O + Al^2 O^3 + 15\ H^2 O$.
		Chalcophanite		256, 257	65	III	$(Mn\ Zn)\ O + 2\ H^2\ O$.
		Psilomelane		257	65	VII	$(Mn\ Ba)\ O + H^2\ O$.
		Wad	Asbolite Lampadite Bog Manganese	257, 258	66	VII	$(Mn\ Ba\ Cu\ Co)\ O + H^2\ O$.

TABLE VI.

THIRD SERIES.—FIFTEEN SPECIES.

Divisions.	Subdivisions.	Group.	Species.	Varieties.	Pages in Dana's System.	No. of Drawer.	Crystal System.	Composition.
Carbonates.	Anhydrous Carbonates.	Calcite	Calcite	Dog-Tooth Spar Iceland Spar Satin Spar Marble Limestone Chalk Oolite Pisolite Stalactite Stalagmite Mexican Onyx Calc Sinter Calc Tufa Travertine	262-271	67-69	III	$CaCO^3$.
			Dolomite		271-273	70, 71	III	$(Ca\,Mg)CO^2$.
			Magnesite	Breunnerite	274, 275	71	III	$MgCO^3$.
			Siderite	Spherosiderite Clay-Ironstone	276-278	72, 73	III	$FeCO^3$.
			Rhodochrosite	Manganocalcite Manganosiderite	278, 279	73	III	$MnCO^3$.
			Smithsonite		279, 280	74, 75	III	$ZnCO^3$.
		Aragonite	Aragonite	Stalactite Stalagmite Coralloidal, or Floss-Ferri	281-283	75-77	IV	$CaCO^3$.
			Witherite		284, 285	77	IV	$BaCO^3$.
			Strontianite		285, 286	77, 78	IV	$SrCO^3$.
			Cerussite		286-289	78, 79	IV	$PbCO^3$.
		Barytocalcite	Barytocalcite		289	79	V	$(Ca\,Ba)CO^3$.
	Hydrous Carbonates.	Malachite	Malachite		294, 295	79-81	V	$2CuCO^3 - H^2O$.
			Azurite		295-298	82	V	$3CuCO^3 + H^2O$.
			Hydrozincite		299	82	VII	$ZnCo^3 + H^2O$.
			Zaratite		306	83	VII	$NiCO^3 + 3H^2O$.

TABLE VIII.

FIFTH SERIES.—FIFTY-FOUR SPECIES.

Serpentines and Talcs	Serpentine	Deweylite		[illegible]	[illegible]	[illegible]	Mg.
		Genthite		676	155	VII	Ni, Mg.
		Garnierite	Noumeite Garnierite	676, 677	156	VII	Ni, Mg.
		Talc	Talc Steatite Rensselaerite	678 680	156-158	IV	Mg.
		Pyrophylite		691, 692	158, 159	V	Al.
		Pinite	Pinite	421, 621	159	VII	Al, K, Fe, Mg, Na, Ca.
			Fahlunite	421			
			Chlorophyllite	421			
			Gigantolite	421, 621			
			Gieseckite	426, 621			
			Liebenerite	426, 621			
			Killinite	368, 621			
			Agalmatolite	622, 691			
			Oösite	622			
		Sepiolite	Meerschaum	680, 681	160	VII	Mg.
Clays	Kaolin	Kaolinite	Kaolinite Pholerite	685-687	160, 161	V	Al.
		Halloysite	Halloysite Indianaite Smectite Fuller's Earth Bole	688, 689 695	161	VII	Al.
		Allophane		693, 694	162	VII	Al.
	Chrysocolla	Chrysocolla		699, 700	162, 163	VII	Cu.
	Hisingerite	Glauconite		683, 684	163	VII	Fe, Al, K, Mg.
		Chloropal		701, 702	163	VII	Fe.
		Hisingerite		702, 703	164	VII	Fe.
		Neotocite		704, 705	164	VII	Mn, Fe, Mg.

One condenser.

One condenser with iris diaphragm.

One Jannettaz's thermal apparatus.

One Latterman's apparatus.

One Fuess's polariscope with accessories.

One Groth's universal apparatus, with goniometer.

One Fuess's application goniometer for dull crystals.

One Fuess's reflection goniometer.

One Hirschwald's microscope goniometer.

One Linholf's reflection goniometer.

One total reflectometer attachment.

Fourteen Miller's goniometers.

One Stage goniometer.

One Bertrand's micro-goniometer with special stage.

One flask for measuring index of fluids.

One pyroelectric duster.

One Streng's chest and apparatus, for microchemical reactions, etc.

About two thousand mineral sections for the microscope.

B—*Lithology.* The instruction in this branch of Petrography comprises both the macroscopic and the microscopic study of rocks. For this work large and complete collections of rock specimens, with numerous thin sections, are arranged for the use of the student. The course of instruction here is similar to that followed in the course in Mineralogy. Lectures are given upon the specimens of the typical collection, the method of classification explained, and the distinguishing characters of the different groups, species, and varieties pointed out. Special attention is called to the variations and alterations in rocks, and to their local modifications due to their special mode of occurrence in the field. The student is to supply himself with the Director's mimeographed Notes on Petrography.

The object of the course is to give the student that training in the practical determination of rocks that will enable him to know them in the field and mine, as well as to observe their alterations and modifications—subjects that have a very important bearing upon the vital questions relating to ore deposits.

After the study of a sufficiently large number of types has been had, the student has assigned to him a large number of drawers containing unlabeled specimens of these rocks, which he is expected to determine and recite upon, as he has done in his study of minerals. The course is thus made thorough and practical, and adapted to the needs of the miner, teacher and geologist, giving them a training which they can make use of in their future work.

The student is drilled at the same time upon both the microscopic and macroscopic characters of the rocks he is studying, as the thin sections of rocks for the most part have been made at the Mining School from the hand specimens in the Lecture Collection of Rocks. All practical students of Petrography will recognize the great advantage of this arrangement.

The subjoined original classification of rocks, prepared in 1878, and subsequently modified by the Director (Table XI), will show the scope of the laboratory work, lectures, and the arrangement of the Lecture Collection of Rocks.

C—*Petrology:* Under this subdivision of Petrography, the various questions relating to the origin, modes of occurrence, relations and alterations of rocks, as observed in the field, are considered, but since the chief portion of the students electing Petrography also elect Physical and Chemical Geology, the majority of the instruction in Petrology is given in connection with that subject.

The entire subject of Petrography is to be taken as a whole, and the student is required to have passed in B 1 (Physics), F 7 (General Chemistry), and W 2 (Mineralogy).

In the above course in Petrography the following collections are used:

1. THIN SECTIONS OF MINERALS AND ROCKS.

Sections of Minerals	2,000
Polariscope Sections	132
Sections of Lecture Rock Collection	2,895
Sections of Michigan Rocks	650
Sections of Rosenbusch Rock Collection	729
Miscellaneous Sections	361
Sections of Stratigraphical Rock Collection	206
	6,973

II. HAND SPECIMENS OF ROCKS.

Lecture Collection of Rocks	3,800
Practice Collection of Rocks	6,500
Lecture Collection of Michigan Rocks	675
Practice Collection of Michigan Rocks	1,300
Rosenbusch Collection of Rocks	1,000
Stratigraphical Collection of Rocks	210
	13,485

Y. GEOLOGY.

THE DIRECTOR, ASSISTANT PROFESSOR SEAMAN AND MR. SUTTON.

Y 1.—*Principles of Geology.*

THE DIRECTOR.

First eight weeks of the fall term: five times a week. To count as one-fifth of a course.

The instruction in this subject is intended as a preparation for the study of the Principles of Mining and the subsequent work in Mineralogy, Petrography, Geology and Mining Engineering. Previous work in Geology, unless taken as a college or as a university course of a satisfactory nature will not be accepted for this subject, which is required of all candidates for the S. B. or E. M. degrees.

The subject is taught by lectures supplemented by the use of Dr. A. Geikie's Class Book in Geology. This is used in order to save as much of the time of the student in taking notes as practicable.

The design of the course is to give a clear and philosophical, but brief and rapid view of the principles that lie at the basis of geological science. The outline scheme of the lectures is given below, but it will be varied from time to time as circumstances indicate.

Outline Course of Lectures on the Principles of Geology.

A. GEOLOGY.

I. Physical Geology.
II. Chemical Geology.
III. Stratigraphical Geology.
IV. Economic Geology.

Divisions I. and II.—Principles of Physical and Chemical Geology.

B. OPTICS.

- I. Light
  - Prism.
  - Spectroscope.
  - Spectrum
    - Incandescent Gasses.
    - White Hot Liquids.
    - White Hot Solids.
    - White Hot Substances surrounded by an atmosphere.

C. UNIVERSE.

- I. Nebulæ
  - Luminous Gas.
  - Gases under pressure, or incandescent Liquids or Solids.
- II. Sun
  - Chromosphere
    - Prominences.
  - Photosphere
    - Sun Spots.
  - Main Body.
  - Corona.
  - Light.
  - Heat.
  - Chemical Elements.
- III. Stars
  - Variable
    - Continuous.
    - Irregular.
    - Temporary.
    - Periodic.
  - Multiple
    - Double Clusters.
  - Spectrum
    - Hydrogen (White or Blue Stars).
    - Metallic (Sunlike Stars).
    - Carbon (Red and Variable Stars).
    - Banded (Small Red Stars).

D. SOLAR SYSTEM.

- I. Exterior Planets
  - Jupiter
    - Physical Constitution (Red Spot).
    - Moons.
  - Saturn
    - Rings.
    - Moons.
  - Uranus.
  - Neptune.
  - Asteroids.
- II. Inner Planets
  - Mars
    - Physical Characters.
    - Moons.
  - Venus.
  - Mercury.
- II. Moon
  - Atmosphere.
  - Surface.

- IV. **Comets**
  - Nucleus.
  - Coma.
  - Tail.
- V. **Meteors**
  - Meteorites.
  - Shooting Stars.
- VI. **Cosmogony**
  - Solar System.
    - Nebular Hypothesis.
  - Universe.

E. EARTH.

- I. **The Earth's Formation**
  - Gaseous Stage.
  - Liquid Stage.
  - Solid Stage.
- II. **The Earth's Interior**
  - Precession and Nutation.
  - Tides.
  - Heat and Pressure.
  - Relation of Liquid and Hot Solid States of Matter.
  - Density.
  - Geological Evidences.
- III. **The Earth's Exterior**
  - Original Crust.
- IV. Eruptive Action.
  - Flowing Lava.
    - Through Fissures.
    - Over the Surface.
    - Contact with Subterranean Waters.
    - Contact with Surface Waters.
    - Quiet Eruptions.
    - Explosive Eruptions.
    - Eruptive Energy Diminishing.
    - Forming Dykes.
    - Forming Flows.
    - Forming Laccolites.
    - Forming Bosses or Masses.
  - Volcanoes.
    - Cone
      - Origin.
      - Form.
      - Structure,
    - Materials
      - Steam, Water.
      - Gases.
      - Ashes, Mud.
      - Stones.
      - Lava.
    - Mud Volcanoes.
    - Solfateras.
    - Geysers.
    - Submarine.
    - Cause of Volcanic Action
      - Davey.
      - Scrope.
      - Mallet.
      - Prestwich.

F. EARTH MOVEMENTS.

I. Tremors and Pulsations.

- II. Elevation of Surface.
  - Animal and Plant Remains.
  - Sea Worn Caves.
  - Raised Beaches.
  - Historical Records.
  - Cause of Upheaval.
- III. Subsidence of Surface.....
  - Submerged Forests.
  - Fiords.
  - Historical Records.
  - Cause of Subsidence.
- IV. Earthquakes .
  - Wave Motion...
    - Shock or Motion.
    - Sea Wave.
    - Earth Wave.
    - Velocity of Wave Motion.
    - Depth of Source.
    - Duration.
    - Area Affected.
  - Fissures or Master Joints.
  - Cause of Earthquakes.

G. EARTH ALTERATION.

- I. Metamorphism
  - Causes..
    - Pressure.
    - Dry Heat.
    - Percolating Waters..
      - Hot.
      - Cold.
    - Chemical Action.
  - Local.
  - Regional.

H. PRINCIPAL MINERALS FORMING ERUPTIVE ROCKS.

I. Foreign or of Prior Origin to the Rock.

(a) *Native Elements:* Iron.

(b) *Oxides:* Quartz, Magnetite.

(c) *Anhydrous Silicates:* Orthoclase, Plagioclase, Leucite, Enstatite, Amphibole (Hornblende), Haüyenite, Noselite, Chrysolite, (Olivine), Biotite.

II. Indigenous or Original: Crystallizing out of the Magma.

(a) *Native Elements:* Graphite, Iron.

(b) *Sulphides:* Pyrrhotite.

(c) *Oxides:* Quartz, Hematite, Spinel (Picotite), Magnetite, Rutile, Zircon.

(d) ***Anhydrous Silicates:*** **Orthoclase (Adularia, Sanidin), Microcline, Plagioclase, Leucite, Enstatite (Bronzite), Pyroxene (Diallage, Augite), Amphibole (Hornblende), Iolite, Nephelite, Chrysolite (Olivine), Titanite, Biotite. (In this case the Biotite is anhydrous.)**

(e) *Phosphates:* Apatite.

III. Secondary Minerals or Alteration Products.

(a) *Sulphides:* Chalcopyrite, Pyrite.

(b) *Oxides:* Quartz (Chalcedony, Agate, Jasper), Hematite, Martite, Magnetite, Spinel, Chromite, Rutile, Zircon, Opal (Hyalite), Limonite.

(c) *Carbonates:* Calcite, Dolomite, Magnesite, Siderite.

(d) *Anhydrous Silicates:* Orthoclase (Microcline), Plagioclase, (Labradorite), Saussurite, Enstatite (Bronzite, Bastite), Pyroxene, (Salite, Diallage), Amphibole (Tremolite, Actinolite, Asbestus, Smaragdite, Uralite, Hornblende), Iolite, Nephelite, (Elaeolite), Cancrinite, Sodalite, Haüynite, Noselite, Epidote, Tourmaline, Titanite.

(e) *Hydrous Silicates:* Zeolites, Prehnite, Apophyllite, Heulandite, Stilbite, Laumontite, Chabazite, Analcite, Datolite, Natrolite, Thomsonite, Pectolite, Muscovite (Sericite), Biotite, Chlorite, Delessite, Serpentine (Chrysotile), Talc (Steatite), Pinite, Kaolinite.

(f) *Phosphates:* Apatite.

(g) *Sulphates:* Gypsum.

I. PRINCIPAL ERUPTIVE (INCLUDING METEORIC) ROCKS.

I. *Original Forms:*

Siderolite, Meteoric Iron, Pallasite, Peridotite; Basalt, Tachylite, Nephelinite or Nephelite Basalt, Leucitite or Leucite Basalt; Andestite, Pyroxene Andesite, Amphibole Andesite; Trachyte, Lassenite (Pumice); Rhyolite, Obsidian (Pumice, Pitchstone, Pearlite, Spherulite), Liparite, Granite; Tufa.

II. ***Metamorphosed Massive Forms:***

Cumberlandite; Serpentine, Ophicalcite, Dolomite; Zirkelite, Melaphyr, Diabase, Gabbro, Norite, Diorite; Phonolite, Propylite, Minette, Syenite; Felsite, Micr的granite, Granite; Porodite.

III. *Metamorphosed Schistose Forms:*

Serpentine, Talc Schist (Steatite), Amphibole Schist, Eclogite, Epidosite, Chlorite Schist; Argillite, Granulite, Quartz Schist, Mica Schist, Gneiss; Jaspilite, Halleflinta; Porodite.

J. DENUDATION OR DESTRUCTIVE AGENCIES.

I. Changes of Temperature.

II. Lightning.. Fulgurites.

III. Air........
- Dry Air.
- Wind, Tempests.

IV.—Surface Waters.
- Rain...... Mechanical.
  - Impact.
  - Raindrop Impressions.
  - Movement of Fragments.
  - Earth Pillars.
- Streams
  - Supply.
  - Discharge.
  - Flow.......
    - Upland.
    - Valley.
    - Plain.
  - Erosion.....
    - Channel.
    - Pot Holes.
    - Valleys.
    - Gorges.
    - Canons.
    - Rapids.
    - Falls.
  - Transportation.
- Lakes....
  - Changes of Level.
  - Waves.
  - Erosion.....
    - Beaches.
    - Cliffs.
  - Transportation.

IV. Surface Waters.—*Continued.*

- Seas
  - Tides
    - Origin.
    - Ebb.
    - Flood.
    - Bore or Eagre.
    - Whirlpools.
    - Erosion.
    - Transportation.
  - Waves
    - Breakers.
    - Ground Swell.
    - Force.
    - Height.
    - Depth.
    - Erosion
      - Force.
      - Hydraulic Pressure.
      - Loose Detritus.
      - Beaches.
      - Cliffs.
    - Transportation.
  - Currents
    - Erosion.
    - Transportation.
  - Earthquake Sea Waves.
- Ice
  - Snow
    - Avalanches.
  - Hail.
  - Nevé or Firn.
  - Glaciers
    - Moraine
      - Lateral.
      - Medial.
      - Ground.
    - Crevasses.
    - Ice Rapids.
    - Ice Falls.
    - Valley Glaciers.
    - Mountain Glaciers.
    - Fragmental Glaciers.
    - Movement
      - Sides.
      - Center.
      - Top.
      - Bottom.
    - Icebergs.
    - Erosion.
    - Transportation.
  - Shore Ice.
  - Ground or Anchor Ice.
  - Sheet Ice (Floe Ice).

- V. Interior Waters
  - Movements
    - Capillarity of Rocks and Soils.
    - Percolation
      - Through Fissures.
      - Through the Rocks.
    - Saturation.
  - Chemical Action
    - Solution.
    - Oxidation.
    - Deoxidation.
    - Hydration.
    - Carbonation.
    - Weathering.
    - Efflorescence.
  - Mechanical Action
    - Erosion.
    - Transportation.
  - Springs
    - Contents
      - Calcareous.
      - Ferruginous or Chalybeate.
      - Salt.
      - Oil.
      - Medicinal
        - Alkaline.
        - Sulphurous.
        - Salt.
        - Bitter.
        - Earthy.
    - State
      - Cold.
      - Hot, Geysers.
  - Wells
    - Common.
    - Artesian.
  - Underground Streams.
  - Underground Lakes.
  - Channels.
  - Caverns.
  - Sink Holes.
  - Land Slides.

- VI. Organic.
  - Plants ....
    - Algæ.
    - Lichens.
    - Roots.
    - Acids.
  - Animal..
    - Tunneling Animals...
      - Sponges.
      - Echinoderms.
      - Earthworms.
      - Mollusks . . . . . .
        - Gastrochæna.
        - Saxacavæ.
        - Pholadiæ.
        - Teredo.
      - Cray-fish.
      - Insects.
      - Rodentia.
      - Insectivora.
    - Man ....
      - Excavation.
      - Dredging.
      - Destruction of plants.
      - Dams.
      - Water Courses.
      - Destruction of Animals.

K. PRINCIPAL MINERALS FORMING SEDIMENTARY ROCKS.

(a) *Native Elements:* Graphite.

(b) *Sulphides:* Sphalerite (Blende) Pyrrhotite, Chalcopyrite, Pyrite, Arsenopyrite (Mispickel).

(c) *Chlorides-Oxides:* Halite, Sylvite, Quartz (Smoky Quartz, Chalcedony, Silicious Sinter, Flint, Jasper), Corundum (Emery), Hematite (Micaceous, Red Ochre), Martite, Ilmenite, Spinel, Magnetite, Rutile, Zircon, Opal, Limonite, (Yellow Ochre, Umber, Bog Ore), Bauxite, Wad (Bog Manganese).

(d) *Carbonates:* Calcite (Limestone, Marble, Chalk, Oolite, Pisolite, Stalactite, Stalagmite), Dolomite, Magnesite, Siderite.

(e) *Anhydrous Silicates:* Orthoclase, Plagioclase, Saussurite, Anthopyllite, Amphibole (Tremolite, Actinolite, Asbestus, Hornblende), Glaucophane, Iolite, Garnet, Andalusite (Chiastolite), Sillimanite (Fibrolite), Cyanite, Epidote, Tourmaline, Staurolite, Titanite.

(f) *Hydrous Silicates:* Muscovite (Sericite), Biotite, Lepidomelane, Chloritoid, Ottrelite, Chlorite, Serpentine, Talc, Pinite, Kaolinite, Glauconite.

(g) *Phosphates:* Apatite (Phosphorite, Guano, etc.).

(h) *Sulphates:* Barite, Celestite, Anhydrite, Gypsum.

(i) *Hydrocarbons:* Asphaltum, Anthracite, Bituminosite, Cannelite, Lignite.

L. SEDIMENTARY ROCKS.

I. *Unconsolidated Forms.*

Laxite: Mud, Sand, Gravel, Shingle, Marl, Clay, Loam, Chalk, Infusorialite (Diatomaceous Earth), Guano, Turf, Peat.

II. *Consolidated Forms.*

Shale, Argillite, Sandstone (Graywacke), Conglomerate, Breccia, Marl, Travertine, Limestone, Dolomite, Tripolite, Sinterite, Millite, Guano, Gypsum, Anhydrite, Asphaltum, Lignite, Cannelite, Bituminosite, Coal.

III. *Consolidated Metamorphosed Forms.*

Slate, Porcelanite, Andalusite Schist, Talc Schist, Chlorite Schist, Amphibole Schist, Mica Schist (Sericite Schist, Graphite Schist), Quartz Schist, Ferruginous Schist, Jaspilite, Quartzite, Conglomerate, Breccia, Gneiss, Protogine, Marble, Ophicalcite, Anthracite.

M. ROCK FORMING AGENCIES (NOT ERUPTIVE).

- I. Air
  - Dust.
  - Dust Showers.
  - Blood Rain.
  - Dunes.
  - Loess.
- II. Surface Waters.
  - Streams
    - Talus.
    - Beds.
    - Banks
    - Flood Plains.
    - Bars.
    - Deltas.
  - Lakes
    - Mechanical
      - Mud } Loess.
      - Clay } Loess.
      - Sand.
      - Gravel.
      - Shingle.
    - Chemical
      - Iron Ore.
      - Salts.
      - Gypsum.
      - Marl.
      - Limestone.
    - Organic
      - Marl.
      - Diatomaceous Earth.
      - Peat.

II. Surface Waters.—*Continued.*

- Seas
  - Mechanical
    - Shore
      - Mud.
      - Sand.
      - Gravel.
      - Shingle.
    - Medial
      - Gravel.
      - Sand.
      - Mud
        - Blue.
        - Green.
        - Coral.
        - Volcanic.
      - Clay or Ooze.
    - Abysmal
      - Red and Gray Clays.
  - Chemical
    - Saline.
    - Calcareous.
    - Gypsiferous.
    - Ferruginous.
    - Maganiferous.
    - Argillaceous.
- Snow
  - Avalanches.
- Ice
  - Glaciers
    - Surface Moraines.
    - Ground Moraines.
    - Terminal Morains.
  - Icebergs.
  - Floe Ice.

III. Interior Waters.

- Surface Deposits
  - Land Slides.
  - Efflorescence.
  - Springs
    - Mechanical—Detritus.
    - Chemical
      - Calcareous.
      - Siliceous.
      - Ferruginous.
  - Artesian Wells.
- Interior Deposits
  - Deposits in Rocks
    - Decomposition.
    - Impregnations or Replacements.
  - Deposits in Cavities
    - Mechanical—Bed Deposits.
    - Chemical—Segregations.

N. PLANTS.

- I. Thallophyta
  - Algæ
    - Diatomaceæ (Diatoms).
    - Chloraphyceæ (Green Seaweeds).
    - Rhodophyeæ (Red Seaweeds).
  - Fungi
    - Lichens.
    - Mushrooms.

- II. Bryophyta
  - Hepaticæ (Liverworts).
  - Musci (Mosses).
- III. Pteridophyta
  - Filicinæ (Ferns).
  - Equisetaciæ (Horsetails).
  - Lycopodinæ (Club Mosses or Ground Pines).
- IV. Gymnospermæ
  - Cycadeæ (Cycads).
  - Coniferæ
    - Fir, Spruce, Hemlock, Pine, Cypress, Redwood, Juniper, Larch, Cedar.
- V. Angiospermæ
  - Monocolyledons
    - Grasses, Palms.
  - Dicotyledons
    - Willow, Oak, Chestnut, Beech, Hickory, Walnut, Elm, Cherry, Maple, etc.

C. ANIMALS.

- I. Infusoria
  - Rhizopoda
    - Foraminifera,
      - Globigerina.
      - Numulites.
      - Eozoon.
    - Radiolaria.
- II. Porifera
  - Siliceous Sponges.
  - Calcareous Sponges.
- III. Coelenterata
  - Hydrozoa
    - Millepora.
    - Graptolites.
    - Stromatopora.
  - Actinizoa
    - Zoantharia
      - Coral.
      - Fringing Reefs
      - Barrier Reefs.
      - Atolls.
      - Limestone.
    - Alcyonaria.
- IV. Echinodermata
  - Asteroidea
    - Star Fishes.
  - Ophiuroide
    - Brittle Stars.
  - Echindea
    - Sea Urchins, Echini.
  - Holothuroidea
    - Sea Cucumbers.
  - Crinoidea
    - Stone Lilies, Crinoids.
  - Cystoidea.
  - Blastoidea.

- V. Vermes
  - Annelida
    - Serpula.
    - Spirorbis.
- VI. Moluscoida
  - Polyzoa.
  - Brachiopoda.
- VII. Mollusca.
  - Lamellibranchiata
    - Asiphonida
      - Oyster, Scallop.
      - Mussel, Lithodomus.
      - Unio.
    - Siphonida
      - Tridacna, Cockle,
      - Clam, Razor Shell,
      - Gastrochaena,
      - Saxicava, Pholas,
      - Teredo.
  - Gastropoda
    - Cone Shell, Cowries, Sea Snails,
    - Periwinkle, River Snails, Limpet,
    - Land Snails, Slugs, Pond Snails.
  - Scaphopoda
    - Dentalium (Tooth Shell.)
  - Cephalopoda
    - Tetrabranchiata
      - Nautilus.
      - Orthocerata.
      - Ammonites.
    - Dibranchiata
      - Argonaut.
      - Octopus.
      - Squid, Cuttle Fish.
- VIII. Arthropoda.
  - Crustacea
    - Entomostraca
      - Cirripedia
        - Acorn Shells or Barnacles.
      - Trilobita.
      - Xiphosura.
      - Eurypterida.
    - Malacostraca
      - Decapoda
        - Lobsters.
        - Cray Fishes.
        - Crabs.
  - Myriopoda
    - Millepedes, Centipedes.
  - Archnida
    - Mites, Ticks, Scorpions, Spiders.
  - Insecta
    - Neuroptera
      - Dragon Fly, May Fly, White Ants.
    - Orthoptera
      - Crickets, Locusts, Grasshoppers, Cockroaches.
    - Hemiptera
      - Bed Bug, Louse, Plant Louse.
    - Coleoptera
      - Beetles.
    - Diptera
      - Flies.
    - Lepidoptera
      - Butterflies, Moths.
    - Hymenoptera
      - Bees, Wasps, Ants.

IX. Vertebrata.	**Tunicata**		**Ascidians.**
	Acrania		**Amphioxus or Lancelet.**
	Pisces or Fishes	**Marsipobranchii**	**Lampreys,** **Hag Fish.**
		Elasmobranchii	**Sharks.** **Rays.**
		Ganoidei	**Sturgeon, Gar Pike,** **Mud Fish.**
		Teleostei	**Salmon, Herring,** **Pike, Perch, Eel,** **Cat Fish, Cod.**
		Dipnoi	**Ceratodus, Protopterus,** **Lepidosiren.**
	Amphibia		**Toads, Frogs, Salamanders, Newts, Mud Puppy.**
	Reptilia	Ophida	**Snakes.**
		Lacertilia	**Lizards.** **Chameleon.** **Iguana.**
		Chelonia	**Turtles.** **Tortoises.**
		Crocodilia	**Alligator.** **Crocodile.** **Gavial.** **Cayman.**
	Aves	Ratitae	**Ostrich, Cassowary,** **Apteryx.**
		Carinatae	**Ducks, Gulls, Divers, Herons, Cranes, Hens, Turkeys, Hawks, Eagles, Owls, Doves, Crows, Swallows, Sparrows.**
	Mammalia	**Monotremata**	**Duckbill, Echidna.**
		Marsupialia	**Kangaroo, Opossum,** **Tasmanian Wolf,** **Tasmanian Devil.**
		Edentata	**Sloths, Ant-eaters,** **Pangolins, Armadillos.**

ABLE XII.—CLASSIFICATION OF UTILITES, OR USEFUL GEOLOGICAL PRODUCTS BASED ON THEIR ORIGIN AND MODES OF OCCURRENCE.

BY M. E. WADSWORTH, 1882-1892.

Eruptive Deposits	Non-Fragmental Deposits	Flow Deposits. Dike Deposits. Mass Deposits.			
	Fragmental Deposits	Bed (Placer) Deposits	Tufa Deposits. Porodite Deposits.		
Chemical Deposits	Impregnations, or Replacement Deposits	Clasolite Deposits	Tufa Deposits. [illegible]		
		Eruptive Rock Impregnations	Fragmental Deposits	Mass Deposits	Carbona Deposits.
				Bed Deposits	Tufa Deposits. Porodite Deposits.
				Clasolite Deposits	Tufa Deposits. Porodite Deposits.
		Sedimentary Rock Impregnations	Bed Deposits	Fahlbands.	
			Clasolite Deposits.		
	Segregations, or Cavity Deposits.	Pocket Deposits. Chamber Deposits.			
		Vein Deposits	Gash Veins. Segregated Veins. Recticulated Veins, or Stockwork. Fissure, or Fault Veins.		

TABLE XIII.—CLASSIFICATION OF UTILITES OR USEFUL GEOLOGICAL PRODUCTS BASED ON THEIR USES.

BY M. E. WADSWORTH, 1893.

Utilites	Ærites, or Metallites		Ores, or Metalliferous Materials.
	Non-ærites, or Memetallites, or Non-metalliferous Materials	Pectonites	Construction Materials or Building and Road Materials.
		Cosmites	Decorative Materials, or Ornamental Stones and Gems.
		Pyrolites	Refractory, or Fire-resisting Materials.
		Chalicites	Binding Materials, or Limes, Mortars, Cements, etc.
		Ceramites	Fictile, or Ceramic Materials.
		Rholites	Smelting Materials, or Fluxes.
		Vitrites	Vitrifying Materials, or Glass, etc.
		Tribolites	Abrasives, or Attrition Materials.
		Thermites	Fuels or Burning Materials, or Carbonites.
		Graphelites	Graphic, or Illustrative Materials.
		Lubricites	Lubricants, or Friction Materials.
		Chromatites	Color Materials, or Paints, Pigments, etc.
		Coprites	Fertilizers, or Mineral Manures.
		Salites	Salts and Saline Materials.
		Ignites	Pyrotechnic Materials.
		Pharmacites	Mineral Medicines.
		Chemites	Chemical Materials.

IX. Vertebrata.—*Continued.*

- Mammalia.
  - **Rodentia** ... Rats, Squirrels, Porcupine, Beaver, Muskrat, Hares, Mice, Prairie Dog.
  - **Insectivora.** Shrews, Moles, Hedgehog.
  - **Chiroptera** .. Bats.
  - **Cetacea** ..... Whales, Porpoises, Dolphins, Narwhale.
  - **Sirenia** ...... Manatee, Dugong.
  - **Proboscidia.** Elephants.
  - **Ungulata** ... Rhinoceros, Horse, Hog, Sheep, Ox, Deer, Tapir, Bison, Giraffe.
  - **Carnivora** . Seal, Walrus, Raccoon, Bear, Otter, Skunk, Weasel, Mink, Fox, Wolf, Dog, Lynx, Panther, Leopard, Tiger, Lion, Cat.
  - **Prosimii** ... Lemurs.
  - **Primates** Monkeys, Apes, (Gibbon, Orang Outang, Chimpanzee, Gorilla), Man.

P. ROCK STRUCTURE.

- I. Sedimentary Rocks ...
  - Laminae.
  - Stratum ..
    - Current Bedding.
    - Wind Drift Structure.
    - Wave Marks.
    - Ripple Marks.
    - Rill Marks.
    - Mud Flows.
    - Sun Cracks.
    - Rain Prints.
    - Gas Pipes.
    - Thickness.
    - Extent
    - Overlap.
  - Clasolite.

- II. Sedimentary and Eruptive Rocks.
  - Outcrop.
    - Strike.
    - Dip.
      - Anticlinical.
      - Synclinal.
      - Monclinal.
      - Qua-qua-versal.
      - Geoclinical.
      - Inversion.
      - Crumpling.
  - Uncomformability.
  - Concretions.
    - Geodes.
  - Deformation.
  - Crushing.
    - Shearing.
  - Joints.
    - Contraction.
    - Pressure.
    - Faults.
      - Normal.
      - Reversed.
  - Cleavage.
    - Mechanical.
      - Sharpe.
      - Sorby.
      - Tyndall.
    - Chemical.
  - Foliation.
    - Mechanical.
    - Chemical.

Q. MOUNTAIN BUILDING.

- I. Upheaval.
  - Volcanic or Eruptive.
  - Flexure.
- II. Denudation.

Division III.—Stratigraphical Geology.

R. GEOLOGICAL FORMATIONS.

- I. Azoic or Archæan.
  - Laurentian.
    - Cascade.
  - Huronian.
    - Republic.
    - Mesnard.
  - Michigan.
    - Holyoke.
    - Negaunee.

II. Palæozoic	Cambrian	Georgian.
		Arcadian.
		Potsdam.
	Lower Silurian	Canadian.
		Trenton.
	Upper Silurian	Niagara.
		Onondaga.
		Lower Helderburg.
	Devonian	Oriskany.
		Corniferous.
		Hamilton.
		Chemung.
	Carboniferous	Subcarboniferous.
		Carboniferous.
		Permian.
III. Mesozoic	Triassic	Vosgian.
		Franconian.
		Keuperian.
		Rhaetic.
	Jurassic	Liassic.
		Oolitic.
		Portlandian.
	Cretaceous	Lower Cretaceous.
		Upper Cretaceous.
IV. Cenozoic	Tertiary	Eocene.
		Oligocene.
		Miocene.
		Pliocene.
V. Anthozoic or Anthropozoic	Quarternary	Glacial.
		Champlain.
		Neitic or Recent.

Division IV.—Economic Geology.

S. UTILITES.

I. Definitions. Ore, Lode, Country Rock, Socialite (Associate or Comrade), Gangue or Veinstone.

II. Minerals Most Commonly Occurring as Socialites or Associates.

(a) *Sulphides:* Galenite, Sphalerite, Pyrite, Pyrrhotite, Arsenopyrite (Mispickel).

(b) *Fluorides and Oxides:* Fluorite, Quartz (Smoky), Hematite (Specular), Ilmenite, Magnetite, Rutile, Opal, Limonite.

- (c) *Carbonates:* Calcite (Dog Tooth Spar), Dolomite, Magnesite, Siderite, Rhodochrosite, Aragonite (Floss-Ferri), Cerussite.
- (d) *Anhydrous Silicates:* Orthoclase, Plagioclase, Saussurite, Wollastonite, Pyroxene (Coccolite), Amphibole (Tremolite' Actinolite, Asbestus, Hornblende), Nephelite, Garnet, Willemite, Scapolite, Vesuvianite, Epidote, Tourmaline, Titanite.
- (e) *Hydrous Silicates:* Prehnite, Apophyllite, Stilbite, Laumontite, Chabazite, Analcite, Datolite, Natrolite, Thomsonite, Pectolite, Muscovite, Lepidolite, Zinnwaldite, Biotite, Chlorite, Serpentine, Talc, Pinite, Kaolinite.
- (f) *Phosphates:* Apatite.
- (g) *Sulphates:* Barite, Celestite, Anglesite, Anhydrite, Gypsum.
- (h) *Tungstates:* Wolframite.

II. Principal Useful Minerals.

- (a) *Native Elements:* Diamond, Graphite, Sulphur, Arsenic, Antimony, Bismuth, Gold, Silver, Copper, Mercury, Platinum.
- (b) *Sulphides:* Realgar, Orpiment, Stibnite, Molybdenite, Argentite, Galenite, Chalcocite, Sphalerite (Blende), Cinnabar, Millerite, Niccolite, Pyrrhotite, Bornite, Chalcopyrite, Stannite, Pyrite, Smaltite, Cobaltite, Arsenopyrite (Mispickel), Bournonite, Pyrargyrite, Proustite, Tetrahedrite, Stephanite, Enargite.
- (c) *Chlorides—Fluorides:* Halite, Sylvite, Cerargyrite (Horn Silver), Embolite, Fluorite, Cryolite, Atacamite, Carnallite.
- (d) *Oxides:* Quartz (Amethyst, Tiger's Eye, Chalcedony, Carnelian, Plasma, Blood Stone, Agate, Moss Agate, Onyx, Flint, Jasper, Silicfied Wood), Senarmontite, Cuprite, Zincite, Tenorite (Malconite), Corundum (Emery), Hematite (Specular, Columnar, Micaceous, Red Ochre), Martite, Ilmenite, Spinel, Magnetite, Franklinite, Chromite, Chrysoberyl, Cassiterite (Tin Stone), Rutile, Zircon, Pyrrhotite, Opal, Manganite, Limmonite (Yellow Ochre, Umber, Bog Ore), Bauxite, Psilomelane, Wad.
- (e) *Carbonates:* Calcite (Iceland Spar, Mexican Onyx, Chalk, Limestone, Marble), Dolomite, Magnesite, Siderite, Rhodocrosite, Smithsonite, Willemite, Strontianite, Cerussite, Malachite, Azurite.
- (f) *Anhydrous Silicates:* Orthoclase (Adularia), Plagioclase (Sunstone, Moonstone, Labradorite), Rhodonite, Amphibole (Asbestus), Beryl, Iolite, Garnet, Chrysolite (Olivine), Willemite, Topaz, Tourmaline.

(g) *Hydrous Silicates:* Calamine, Muscovite, Serpentine (Chrysotile), Garnierite, Talc, Sepiolite, Kaolinite, Halloysite (Fuller's Earth), Chrysocolla, Glauconite.

(h) *Phosphates:* Apatite (Phosphorite, Guano, etc.), Pyromophite, Mimetite.

(i) *Borates:* Boracite, Borax.

(j) *Uraninates:* Uranite.

(k) *Sulphates:* Glauberite, Barite, Celestite, Anglesite, Anhydrite, Gypsum (Selenite, Satin Spar, Alabaster), Aluminite, Alunite,

(l) *Tungstates:* Wolframite.

(m) *Hydrocarbons:* Ozocerite, Succinite (Amber), Petroleum, Asphaltum, Albertite, Uintahite, Anthracite, Bituminosite (Bituminous Coal), Cannelite (Cannel Coal), Lignite (Brown Coal, Jet).

III. ORIGIN AND MODES OF OCCURRENCE OF UTILITES, OR USEFUL GEOLOGICAL PRODUCTS.

1. Eruptive Deposits
   - Non-Fragmental Deposits,
     - Flow Deposits.
     - Dike Deposits.
     - Mass Deposits.
   - Fragmental Deposits,
     - Bed Deposits.
2. Organic Deposits
   - Vegetable Deposits,
     - Bed Deposits.
   - Animal Deposits,
     - Bed Deposits.
3. Mechanical Deposits
   - Unconsolidated Deposits,
     - Placer or Bed Deposits.
   - Consolidated Deposits,
     - Bed Deposits.
4. Chemical Deposits
   - Sublimations, or Vapor Deposits.
   - Water Deposits,
     - Bed Deposits.
   - Decomposition Deposits,
     - Bed Deposits.
   - Impregnations, or Replacement Deposits,
     - Eruptive Rock Impregnations.
       - Carbona Deposits
     - Sedimentary Rock Impregnations,
       - Bed Deposits.
   - Segregations, or Cavity Deposits,
     - Pocket Deposits.
     - Chamber Deposits.
     - Vein Deposits,
       - Gash Veins.
       - Segregated Veins.
       - Recticulated Veins, or Stockworks.
       - Fissure, or Fault Veins.

IV. USE OF GEOLOGICAL PRODUCTS—*See Table* XIII.

Y 2. *Stratigraphical Geology.*

ASSISTANT PROFESSOR SEAMAN AND MR. SUTTON.

Winter term, three hours a week, fourteen weeks. To count for two-fifths of a course.

The instruction in this subject will consist of recitations and laboratory work and will be given following V 2 (Zoology and Palaeontology). The main object of the course will be to familiarize the student with the life history of the earth, and with the lithological characters, mode of formation, order of superposition, times of upheaval, and distribution in time and space, of the formations which compose the earth's crust.

There will be laboratory drill in assigning fossils to their proper geological horizon. In this work the student will have access to palaeontological literature, with which the library is well supplied. The material at present accessable for the laboratory work consists of a palaeontological collection of four thousand specimens, three small rock collections, one European and two American, containing six hundred specimens arranged stratigraphically, and over one thousand specimens of sedimentary rocks belonging to the lithological collection.

In addition to the above, some time will be given to surface geology in which the present contours of the earth's surface will be discussed.

The text-book used is Dana's Manual of Geology, 4th Edition.

Y 3.—*Physical and Chemical Geology.*

THE DIRECTOR.

Winter term, three hours a week, fourteen weeks.

To count as a two-fifths course.

The instruction in Physical Geology is intended to be especially adapted to the needs of the explorer, the teacher, the engineer, the petrographer, the geologist, the miner, the quarryman, and all others who desire to understand the connection and the structural relations that rock masses have to one another and to the valuable deposits which they may contain. It treats of the origin and alterations of rocks, of general volcanic and earthquake action, metamorphism, jointing, faulting, cleavage, mountain building, eruptive rocks and crystalline schists; the action of air, surface and underground waters, and life; the interior condition of the earth, etc., especially in their relations to the problems that the economic geologist, miner and quarryman have to meet. The student has brought before him constantly the various problems that arise in practical work and the methods of their solution.

This course enlarges and completes much that is briefly touched upon in the Principles of Geology and in Petrography.

The instruction is given by lectures and by recitations based upon the lectures and upon Dr. Archibald Geikie's Text Book of Geology, third edition, 1893, books I, II (part I), III, IV and VII.

Students who take this subject must have completed subjects W 2 (Mineralogy), and Y 2 (Stratigraphical Geology), and must either have completed, or take in connection with this, X 1 (Petrography).

Y 4. *Geological Field Work.*

ASSISTANT PROFESSOR SEAMAN AND MR. SUTTON.

Forty-five hours a week for the last six weeks of the Summer term. To count as a full course. The instruction in this subject begins early in July, and consists of six weeks practical work in the field, mostly amongst the pre-Cambrian rocks of the Lake Superior region.

The first two weeks of the course are spent at compass work, in which the student is trained in pacing, and in the use of the dial and dip compass and aneroid barometer. This work consists of running section lines, meandering woods, roads and streams, running contour lines, platting outcrops, in fact making a complete map of the traverses. Specimens are collected, and must be located with reference to some section, corner or quarter post established by the United States linear survey. On this work the student plats all of his work in the field, keeping his latitude and departure by means of his compass course and pacing.

After the students become more or less adept at platting and compass work, they are given special small areas to map in detail, and to work out the relations of the rocks. They make sections and plans showing these relations, and are required to write descriptions of the specimens collected, and to explain the geological phenomena observed.

Considerable time is spent in the study of the older granites, gneisses, and hornblende schists with their varied accompaniment of basic and acid intrusives comprising what is termed the Cascade formation.

Next in order are studied the great series of clastics that rest nonconformably upon the Cascade formation. These clastics are found to be capable of division into a lower and an upper series termed respectively the Republic and Holyoke formations with both of which are associated large bodies of iron ore. These ore bodies are studied with reference to their origin, and maps and sections are made showing their mode of occurrence, and their relations to the associated rocks.

The last week of the course is devoted to the study of the interbedded sandstones and old lava flows of Keweenaw Point. These rocks are termed the Keweenawan formation. Lastly a day or two is spent along the contact line between the Keweenawan rocks and the Eastern sandstones, in studying their relative stratigraphical position.

The department is well supplied with the instruments necessary for this work, and note books with special ruling are furnished the student at cost.

All students entering the Mining School for instruction in this subject (Y 4) alone, should have a fair knowledge of Mineralogy, Lithology and General Geology if they wish to fully profit by the course.

The other students of the Mining School who elect this subject are required to have passed in Q 1 (Surveying), L 3 (Topographical Drawing), W 2 (Mineralogy), Y 2 (Stratigraphical Geology), and Y 3 (Physical Geology).

Y 5.—*Economic Geology.*

THE DIRECTOR.

Three times a week for twenty-eight weeks, during the fall and winter term. To count for four-fifths of a course.

In this subject, the instruction will take up the geology of the useful. or economic, mineral products considered from two different points of view.

1st. Their origin and modes of occurrence.

2d. Their uses.

The general ground covered by the lectures is shown by two original classifications—the first blocked out in 1882 and subsequently modified, and the second prepared in 1893. The first classification relating to the modes of occurrence of products, treated in the course of Economic Geology, is shown in Table XII; while that covered by the lectures relating to the uses of these products is shown in a general way by Table XIII.

Special attention is given to the instruction of the student in Mineralogy, Petrography and Geology, in order that he may in after years understand the nature of the deposits upon which he may be at work; since disastrous mistakes probably occur in the practice of a mining engineer oftener through ignorance of the petrographical and geological relations of the ore deposits in question, than from lack of engineering or metallurgical skill.

The location of the school affords special advantages for the study of Petrography and General and Economic Geology. It is situated in the midst of the vast and ancient lava flows and conglomerates generally known as the Keweenaw formation and the Eastern or Potsdam Sandstone. In the immediate vicinity are to be solved some of the most important and fundamental problems of petrographical and geological science, e. g., the metamorphism, or alteration of rocks; the true age of the so-called Keweenaw series, the origin of the iron ore, etc.; while almost every problem of Geology finds its illustration in some portion of the Upper Peninsula.

The student of geology can study within the limits of the Uppe- Peninsula of Michigan the following stratigraphical formations, commencing in the list with the oldest.

Azoic or Archaean System	Laurentian	Cascade.
	Huronian	Republic. Mesnard.
	Michigan	Holyoke. Negaunee.
Palæozoic System	Cambrian	Potsdam. (Keweenawan). Calciferous.
	Silurian	Trenton. Hudson River. Niagara. Onondaga. Lower Helderberg.
	Devonian	Upper Helderberg.
Anthropozoic or Anthozoic System,	Quaternary	Glacial. Champlain. Neitic or Recent.

The instruction in the various departments under the immediate charge of the Director is intended to be given so that all those who wish to obtain a knowledge of the subjects as a matter of general information, or to prepare themselves to be teachers or investigators, can attend with advantage. All those who expect to give any time to mine superintendence, should pay special attention to geology.

Subject Y 5 (Economic Geology) is open only to those who have passed in R 1 (Principles of Mining), X 1 (Petrography), Y 3 (Physical Geology), and Y 4 (Geological Field Work).

(Subject Y 5 will not be given in 1896-97).

J. THESIS.

THE FACULTY.

Properly qualified students who so desire may include in their list of electives a thesis which shall be considered equal in value to a full course. The object of this departure from the usual custom of engineering schools is to save the time wasted by so many students in preparing a thesis simply to obtain a degree, when they have no real interest in the subject about which they write, nor practical knowledge of it. Their time is much more profitably employed when spent in systematic study under regular instruction.

It is hoped and expected that by making the thesis elective, more valuable work and results, which shall be real contributions to knowledge, can be obtained.

J 1.—*Thesis.*

The time supposed to be given to this work is nine hours a week for thirty-four weeks, and the thesis, if accepted, is to count as a full course. The subject of the thesis is to be handed in simultaneously with the other electives. The work is to be done under the direction and with the approval of some instructor or instructors, and the subject and thesis must be approved by the Director.

The student must have taken all the necessary preparatory work that is required to enable him to properly handle his subject, or it will not be approved by the Director. The instructor or instructors under whom the thesis work is done must have presented to the Secretary a written statement certifying that the student is properly prepared and able in their judgment to accomplish the work specified. This statement is to accompany the elective schedule.

The thesis must be completed by July 1st and submitted to the Faculty for examination and acceptance, but in no case will the thesis be accepted unless the instructor or instructors under whom

the thesis work was done shall have attached to it a written statement that they approve the thesis and recommend its acceptance by the Faculty.

PREPARATORY SUBJECTS.

Work of this character was first introduced in September, 1895, owing to circumstances over which the Mining School had no control. Since then those circumstances have changed and it is intended to drop again all work of a preparatory nature after June, 1897. No general preparatory department has been added, but a few elective studies are given, to be taken by persons whose training is defective in certain of the required preparatory subjects.

These subjects are as follows :

I. *Elementary Algebra.*

MR. FISHER.

A course for beginners, covering the fundamental operations, factoring, fractions, equations, simple and quadratic roots and indices.

Van Velzer and Slichter's School Algebra is used as a text-book.

Three times a week for thirty-four weeks.

II. *Geometry.*

MR. FISHER.

This subject includes Plane, Solid and Spherical Geometry, and is given from Van Velzer and Schutz's Suggestive Geometry.

Three times a week for thirty-four weeks.

III. *Elementary Physics.*

MR. KNOX.

A course for beginners, covering the beginnings of Mechanics, Sound, Heat, Light, Magnetism, and Electricity. Qualitative experiments are freely used, though the greater part of the laboratory work is quantitative. Hall and Bergen's Text-Book of Physics and Carhart and Chute's Elements of Physics are the text-books.

Three times a week thirty-four weeks.

Must be preceded by, or accompanied with, subjects I (Elementary Algebra) and II (Geometry).

IV. *Bookkeeping.*

MR. FISHER.

This is a general course covering the requirements in this subject for admission to the Mining School. The instruction is intended to comprise the principles of single and double entry, business forms, laws of contracts, etc.

The Complete Practical Bookkeeping has been used as a text-book.

Three times a week for fourteen weeks during the fall term.

V. *Astronomy.*

MR. FISHER.

Three times a week for twenty weeks, during the winter term, and the first six weeks of the summer term

The work in this subject comprises the elementary principles of Astronomy, using Young's Lessons in Astronomy.

Must be preceded by, or accompanied with, subjects I (Elementary Algebra), II (Geometry), and III (Elementary Physics).

DEGREES.

Three degrees are offered by the Mining School as follows:

BACHELOR OF SCIENCE, S. B.
MINING ENGINEER, E. M.
DOCTOR OF PHILOSOPHY, PH. D.

The conditions under which the first two will be given are as follows:

All candidates for the degree of S. B. are required to pass in eighteen full courses, including subjects R 1 (Principles of Mining) and Y 1 (Principles of Geology).

All candidates for the degree of Mining Engineer are required to pass in twenty-two full courses, including subjects R 1 (Principles of Mining) and Y 1 (Principles of Geology).

The degree of Ph. D. will be given under the following conditions:

Students who are E. M. graduates of this institution, or graduates of other institutions of similar grade, whose course shall be approved by the Faculty, will be admitted as candidates for the degree of Doctor of Philosophy. In order to attain this degree they must pursue, for at least two years, advanced studies in subjects allied to the work of this institution, which studies are to be approved by the Faculty.

One of the years may, in special cases, be spent elsewhere, and the work accepted, on sufficient proof of its thoroughness and high character, as the equivalent of one year's work done here. But under no condition will this degree, or any other degree, be given unless at least one year of thirty-four weeks of actual school work be spent as a resident student at this institution.

Students who are E. M. graduates of this, or of an equivalent professional school, and also A. B. graduates of some college or university whose course of study is accepted by the Faculty, may be admitted to the degree of Doctor of Philosophy, after having taken for at least one year of thirty-four weeks, an approved course of study at this institution.

The degree of Doctor of Philosophy will be given only in case the student shall have shown marked ability and power for original investigation, shall have passed a satisfactory oral public examination, and presented a thesis, which shall embody the result of original investigation, and receive the approval of the Faculty.

The degree of Mining Engineer will carry with it also the degree of Bachelor of Science, if the candidate for the degree of E. M. shall make application for the S. B. degree and pay the required fee, which until after August 1897 will be $5.00 for each degree for all students who entered the Mining School prior to commencement, 1895, and who graduate before September, 1897. All others will pay fees according to the following list, which after August, 1897, will apply to every candidate for a degree.

Bachelor of Science	$15 00
Mining Engineer	25 00
Doctor of Philosophy	50 00

No degree will be conferred until the required fee has been paid, which payment must be made to the Treasurer prior to August first.

TEXT-BOOKS—1895-1897.

A.—*Mathematics.*

A 1. College Algebra, 1891. G. A. Wentworth.
Ginn & Co., Boston.

A 2 and 3. Plane and Spherical Trigonometry, 1893. N. H. Wheeler.
Ginn & Co., Boston.

A 2 and 3. Logarithmic Tables. Last Edition. G. W. Jones.
G. W. Jones, Ithaca, New York.

A 4. Analytic Geometry. Last Edition. G. A. Wentworth.
Ginn & Co., Boston.

A 5. Element of the Calculus. Last Edition. J. M. Taylor.
Ginn & Co., Boston.

A 5. Manuscript Notes on Calculus. 1893. F. W. McNair.

A 6. A Treatise on Ordinary and Partial Differential Equations. W. W. Johnson. John Wiley & Sons, New York.

B. *Physics.*

B 1. Manuscript Notes in Physics. 1894-1895. F. W. McNair.

B 1. Laboratory Course in Physics. Last Edition. W. C. Sabine.
Ginn & Co., Boston.

B 1. Heat and Light. 1894. R. T. Glazebrook.
The Macmillan Co., New York.

B 1. Mechanics for Beginners. Last Edition. J. B. Lock.
The Macmillan Co., New York.

B 1. Electricity and Magnetism. 1895. S. P. Thompson.
The Macmillan Co., New York.

B 2 and 3. A Laboratory Manual of Physics and Applied Electricity. E. L. Nichols. The Macmillan Co., New York.

B 2. Lessons on Elementary Practical Physics. Vols. I and II. Balfour Stewart and W. W. Haldane Gee.

B 3. Electrical Measurements, H. S Carhart and G. W. Patterson, Jr.
Allyn & Bacon, Boston.

C. *Mechanics.*

C 1 and 2. Mechanics of Engineering. I. P. Church.
John Wiley & Sons, New York.

F. *Chemistry.*

F 1. Manuscript Notes on General Chemistry. 1893. George A. Koenig.

F 1. Manuscript Notes on Experimental Chemistry. 1893. George A. Koenig.

F 2. Manual of Determinative Mineralogy. Thirteenth Edition. George J. Brush. John Wiley & Sons, New York.

F 2. Landauer's Blowpipe Analysis. 1892. Translated by James Taylor. The Macmillan Co., New York.

F 3. A System of Instruction in Qualitative Analysis. 1893. A. H. Elliott. A.H. Elliott, New York.

F 4. A System of Instruction in Quantitative Chemical Analysis. C. R. Fresenius. Tenth Edition. Edited by O. D. Allen and S. W. Johnson. John Wiley & Sons, New York.

F 4. Manuscript Notes in Quantitative Analysis. 1895–1896. G. A. Koenig.

G. *Metallurgy.*

G 1. Manuscript Notes in Assaying. 1895. George A. Koenig.

G 2. Metallurgy of Lead. 1892. H. O. Hofman.
Scientific Publishing Co., New York.

G 2. Modern American Methods of Copper Smelting. Seventh Edition. 1895. E. D. Peters.
Scientific Publishing Co., New York.

L. *Drawing.*

L 1. Copy Book of Round Writing (School Edition). F. Soennecken.
Keuffel & Esser Co., New York.

L 1. Elements of Mechanical Drawing. Last Edition. G. C. Anthony. D. C. Heath & Co., Boston.

L 1. Machine Drawing. Last Edition. G. C. Anthony.
D. C. Heath & Co., Boston.

L 4. Trusses and Arches. 1890–1891. Charles E. Greene.
John Wiley & Sons, New York.

L 5. Printed Notes on Construction. 1892–1893. Edgar Kidwell.

L 5. Manuscript Notes on Roof Truss Designing. 1892–1893. Edgar Kidwell.

L 5. Manuscript Notes on Railway Trestles. 1892–1893. Edgar Kidwell.

L 6. Manual of Machine Drawing and Design. 1893. D. A. Low and A. W. Bevis. Longmans, Green & Co., New York.

L 6. Elements of Machine Design. Last Edition. W. Cawthorne Unwin. Longmans, Green & Co., New York.

M. *Mechanical Engineering.*

M 1. South Kensington Notes on Building Construction. Vol. III. 1889. Rivingtons, London.

M 2. Pattern Maker's Assistant. Latest Edition. Joshua Rose.
D. Van Nostrand Co., New York.

M 2. Complete Practical Machinist. Last Edition. Joshua Rose.
D. Van Nostrand & Co., New York.

M 4. Text Book on the Mechanics of Materials. 1895. Fifth Edition. Mansfield Merriman. John Wiley & Sons, New York.

M 5. Constructive Steam Engineering. 1890. J. M. Whitham.
John Wiley & Sons, New York.

M 5 and 9. Pumping Machinery. 1893. W. M. Barr.
J. B. Lippincott Co., Philadelphia.

M 7. Valve Gears for Steam Engines. 1892. C. H. Peabody.
John Wiley & Sons, New York.

M 8 and 9. Thermodynamics of the Steam Engine and Other Heat Engines. 1889. C. H. Peabody. John Wiley & Sons, New York.

N. *Electrical Engineering.*

N 1 and 3. Incandescent Wiring Hand Book. Last Edition. F. B. Badt. Electrician Publishing Co., Chicago.

N 1 and 3. Electrical Engineering. Last Edition. W. Slingo and A. Brooker. Longmans, Green & Co., New York.

N 2 and 3. Electricity and Magnetism. 1895. Francis E. Nipher.
J. L. Boland Book Co., St. Louis.

N 3. Electric Motive Power. Albion T. Snell.
Electrician Publishing Co., London.

Q. *Civil Engineering.*

Q 1. Theory and Practice of Surveying. Last Edition. J. B. Johnson.
John Wiley & Sons, New York.

Q 1. Field Engineering. Last Edition. William H. Searle.
John Wiley & Sons, New York.

Q 2. A Treatise on Hydraulics. Fourth Edition. Mansfield Merriman.
John Wiley & Sons, New York.

R. *Mining Enigneering.*

R 1. A Text-Book of Ore and Stone Mining. 1894. C. LeNeve Foster.
C. Griffin & Co., London.

R 2. Manuscript Notes in Mine Surveying and Mining. Revised 1895. F. W. Sperr.

R 4. Manuscript Notes of Mining Engineering. Revised, 1894–1895. F. W. Sperr.

R 5. Manuscript Notes on Mine Management and Accounts. Revised, 1895. F. W. Sperr.

R 5. Engineering Contracts and Specifications. 1895. J. B. Johnson.
Engineering News Publishing Co., New York.

S. *Ore Dressing.*

S 1. Manuscript Notes on Ore Dressing. 1895. F. W. Sperr.

V. *Biology.*

V 2. Elements of Zoology. Manuscript. 1889. M. E. Wadsworth.

V 2. Orton's Comparative Zoology. 1894. Charles Wright Dodge.
Harper & Brothers, New York.

V 2. Elementary Palæontology. 1893. H. Woods.
The Macmillan Co., New York.

V 2. Manuscript notes on Palæontology. 1893. A. E. Seaman.

W. *Mineralogy.*

W 1. Manuscript Notes on Crystallography. 1893. A. E. Seaman.

W 2. The System of Mineralogy. Sixth Edition. 1892. James D. Dana and E. S. Dana. John Wiley & Sons, New York.

W 2. Practical Determination of Minerals—Manuscript. 1876-1892. M. E. Wadsworth.

X. *Petrography.*

X 1. Introduction to Optical and Microscopic Mineralogy—Manuscript. 1877-1893. M. E. Wadsworth.

X 1. Practical Determination of Rock Forming Minerals. Manuscript. 1877-1893. M. E. Wadsworth.

X 1. Microscopical Physiography of the Rock Making Minerals. Third edition. 1893. H. Rosenbusch. Translated by J. P. Iddings. John Wiley & Sons, New York.

X 1. A Manual of Microchemical Analysis. 1891. H. Behrens. The Macmillan Co., New York.

X 1. Tableau des Birefringences. 1888. A. Michel Levy and A. Lacroix. Baudry et Cie, Paris.

X 1. Elements of Lithology—Manuscript. 1877-1893. M. E. Wadsworth.

Y.—*Geology.*

Y 1. Class Book of Geology. Second Edition. Archibald Geikie. The Macmillan Co., New York.

Y 1. Compend of Geology. Last Edition. Joseph LeConte. D. Appleton & Co., New York.

Y 1 and 3. Principles of Geology—Manuscript. 1880-1895.

Y 1 and 5. Introduction to Economic Geology—Manuscript. 1892. M. E. Wadsworth.

Y 2. Manual of Geology. Fourth Edition. 1895. James D. Dana. John Wiley & Sons, New York.

Y 3. Text-Book of Geology. Third Edition. Archibald Geikie. The Macmillan Co., New York.

Y 5. Building Stones—Manuscript. 1878. M. E. Wadsworth.

PREPARATORY STUDIES.

I. School Algebra, 1894. Van Velzer and Slichter.
Tracy, Gibbs & Co., Madison, Wis.

II. Plane and Solid Geometry, 1895. Van Velzer and Schutz.
Tracy, Gibbs & Co., Madison, Wis.

III. Principles of Physics, 1895. A. P. Gage.
Ginn & Co., Boston.

IV. Complete Practical Book-Keeping.
The Practical Text Book Co., Cleveland.

V. Lessons in Astronomy, 1895. C. A. Young.
Ginn & Co., Boston.

ADVISORY ELECTIVE SCHEDULES.

In electing his course of study the student is at liberty to select any subjects he desires, provided that his choice does not conflict with the natural sequence of studies, *i. e.*, he is not to take any study until he has properly prepared himself in the studies that lead up to the one selected. The effort to choose his studies judiciously and in order is a laborious one for a student just entering upon his professional preparation, therefore a series of advisory schedules has been made as guides to students in making their selections.

The student is at perfect liberty to follow any other of the numerous schedules that can readily be laid out, and each member of the Faculty will be pleased to assist anyone who wishes aid in arranging his scheme of studies.

The schedules here given assign to one year more work than can properly be accomplished in a year's time by any but the best and ablest students, and all are advised to choose fewer rather than more studies each year.

From six to eight full courses in one year of forty-five weeks are all that should be undertaken, while if the year is limited to thirty-four weeks, from four to seven is the limit. The student gains far more if he takes only what he can do expediently and thoroughly, and as a rule graduates sooner, than if he selects more subjects than he is able to carry.

The fourth year given is a graduate year in every case, since the student can obtain his degree in the first three years, if he is able to carry seven and two-fifths courses each year.

PRINCIPAL OBJECT—CHEMISTRY OR GEOLOGY.

First Year—Seven and Four-fifths Courses.

A 1. Algebra, 1.*
A 2. Plane Trigonometry, 2-5.
A 3. Spherical Trigonometry, 1-5.
A 4. Analytic Geometry, 4-5.
B 1. Physics, 1.
F 1. General Chemistry, 4-5.
F 2. Blowpipe Analysis, 1-5.
L 2. Topographical Drawing, 1-5.
Q 1. Surveying, 2.
R 1. Principles of Mining, 3-5.
V 1. Economic Botany, 1-5.
W 1. Crystallography, 1-5.
Y 1. Principles of Geology, 1-5.

Second Year—Seven and Four-fifths Courses.

F 3. Qualitative Analysis, 4-5.
L 1. Mechanical Drawing, 1.
L 3. Topographical Drawing, 1-5.
M 1. Properties of Materials, 3-5.
M 2. Shop Practice, 2.
R 2. Mine Surveying and Mining, 2-5.
R 3 Mine Surveying and Mining (Practice), 1.
V 2. Zoology and Palæontology, 2-5.
W 2. Mineralogy, 1.
Y 2. Stratigraphical Geology, 2-5.

Third Year—Seven and Four-fifths Courses

A 5. Calculus, 1.
B 2. Physical Measurements, 1-5.
C 1. Analytic Mechanics, 2-5.
F 4. Quantitative Analysis, 1.
F 5 Quantitative Analysis, 1.
G 1. Assaying, 2-5.
G 2. Metallurgy, 1.

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* The numerals given after the name of the subject indicate the value of it in courses or parts of a course.

R 5. Mine Management and Accounts, 2-5.
X 1. Petrography, 1.
Y 3. Physical Geology, 2-5.
Y 4. Geological Field Work, 1.

Fourth Year—Seven and Four-fifths Courses.

B 3. Electrical Measurements, 1.
C 2. Analytic Mechanics, 2-5.
F 6. Synthetic Chemistry, 2.
G 3. Metallurgical Experimentation, 1.
M 3. Mechanism, 2-5.
Q 2. Hydraulics, 3-5.
R 3. Mining Engineering, 3-5.
S 1. Ore Dressing, 1.
Y 5. Economic Geology, 4-5.

PRINCIPAL OBJECT—METALLURGY.

First Year—Seven and Four-fifths Courses.

A 1. Algebra, 1.
A 2. Plane Trigonometry, 2-5.
A 3. Spherical Trigonometry, 1-5.
A 4. Analytic Geometry, 4-5.
B 1. Physics, 1.
F 1. General Chemistry, 4-5.
F 2. Blowpipe Analysis, 1-5.
L 2. Topographical Drawing, 1-5.
Q 1. Surveying, 2.
R 1. Principles of Mining, 3-5.
V 1. Economic Botany, 1-5.
W 1. Crystallography, 1-5.
Y 1. Principles of Geology, 1-5.

Second Year—Seven and Four-fifths Courses.

A 5. Calculus, 1.
C 1. Analytic Mechanics, 2-5.
F 3. Qualitative Analysis, 4-5.
L 1. Mechanical Drawing, 1.
L 3. Topographical Drawing, 1-5.
M 1. Properties of Materials, 3-5.

M 2 Shop Practice, 2.
R 2. Mine Surveying and Mining, 2-5.
R 3. Mine Surveying and Mining (Practice), 1.
V 2 Zoology and Palæontology, 2-5.

Third Year—Eight Courses.

C 2. Analytic Mechanics, 2-5.
F 4. Quantitative Analysis, 1.
F 5. Quantitative Analysis, 1.
G 1. Assaying, 2-5.
G 2. Metallurgy, 1.
L 4. Graphical Statics, 2-5.
M 3. Mechanism, 2-5.
M 4. Mechanics of Materials, 1.
M 5. Mechanical Engineering, 1.
W 2. Mineralogy, 1.
Y 2. Stratigraphical Geology, 2-5.

Fourth Year—Eight Courses.

F 6. Synthetic Chemistry, 2.
G 3. Metallurgical Experimentation, 1.
G 4. Metallurgy and Designing, 1.
Q 2. Hydraulics, 3-5.
S 1. Ore Dressing, 1.
X 1. Petrography, 1.
Y 3. Physical Geology, 2-5.
Y 4. Geological Field Work, 1.

PRINCIPAL OBJECT—MECHANICAL ENGINEERING.

First Year—Seven and Four-fifths Courses.

A 1. Algebra, 1.
A 2. Plane Trigonometry, 2-5.
A 3. Spherical Trigonometry, 1-5.
A 4. Analytic Geometry, 4-5.
B 1. Physics, 1.
F 1. General Chemistry, 4-5.
F 2. Blowpipe Analysis, 1-5.
L 2. Topographical Drawing, 1-5.

Q 1. Surveying, 2.
R 1. Principles of Mining, 3-5.
V 1. Economic Botany, 1-5.
W 1. Crystallography, 1-5.
Y 1. Principles of Geology, 1-5.

Second Year—Seven and Four-fifths Courses.

A 5. Calculus, 1.
C 1. Analytic Mechanics, 4-5.
F 3. Qualitative Analysis, 4-5.
L 1. Mechanical Drawing, 1.
L 3. Topographical Drawing, 1-5.
M 1. Properties of Materials, 3-5.
M 2. Shop Practice, 2.
R 2. Mine Surveying and Mining, 2-5.
R 3. Mine Surveying and Mining (Practice), 1.
V 2. Zoology and Palæontology, 2-5.

Third Year—Eight Courses.

B 3. Electrical Measurements, 1.
C 2. Analytic Mechanics, 2-5.
G 2. Metallurgy, 1.
L 4. Graphical Statics, 2-5.
M 3. Mechanism, 2-5.
M 4. Mechanics of Materials, 1.
M 5. Mechanical Engineering, 1.
M 6. Testing Materials of Engineering. 1.
N 1. Electrical Engineering, 4-5.
W 2. Mineralogy, 1.

Fourth Year—Eight Courses.

F 4. Quantitative Analysis, 1.
G 1. Assaying, 2-5.
L 6. Machine Design, 1.
M 7. Valve Gears, ½.
M 8. Thermodynamics, ½.
M 9. Mechanical Laboratory, 2.
N 2. Electricity and Magnetism, ½.
N 3. Electrical Engineering, ½.
Q 2. Hydraulics, 3-5.

R 4. Mining Engineering, 3-5.
Y 2. Stratigraphical Geology, 2-5.

PRINCIPAL OBJECT—ELECTRICAL ENGINEERING.

First Year—Seven and Four-fifths Courses.

A 1. Algebra, 1.
A 2. Plane Trigonometry, 2-5.
A 3. Spherical Trigonometry, 1-5.
A 4. Analytic Geometry, 4 5.
B 1. Physics, 1.
F 1. General Chemistry, 4-5.
F 2. Blowpipe Analysis, 1-5.
L 2. Topographical Drawing, 1-5.
Q 1. Surveying, 2.
R 1. Principles of Mining, 3-5.
V 1. Economic Botany, 1-5.
W 1. Crystallography, 1-5.
Y 1. Principles of Geology, 1-5.

Second Year—Seven and Four-fifths Courses.

A 5. Calculus, 1.
C 1. Analytic Mechanics, 2-5.
F 3. Qualitative Analysis, 4-5.
L 1. Mechanical Drawing, 1.
L 3. Topographical Drawing, 1-5.
M 1. Properties of Materials, 3-5.
M 2. Shop Practice, 2.
R 2. Mine Surveying and Mining, 2-5.
R 3. Mine Surveying and Mining (Practice), 1.
V 2. Zoology and Palæontology, 2-5.

Third Year—Eight Courses.

B 2. Electrical Measurements, 1.
C 2. Analytic Mechanics, 2-5.
G 2. Metallurgy, 1.
L 4. Graphical Statics, 2-5.
M 3. Mechanism, 2-5.
M 4. Mechanics of Materials, 1.
M 5. Mechanical Engineering, 1.

M 6. Testing Materials of Engineering, 1.
N 1. Electrical Engineering, 4-5.
W 2. Mineralogy, 1.

Fourth Year—Eight Courses.

F 4. Quantitative Analysis, 1.
G 1. Assaying, 2-5.
L 6. Machine Design, 1.
M 7. Valve Gears, ½.
M 8. Thermodynamics, ½.
N 2. Electricity and Magnetism, ½.
N 3. Electrical Engineering, ½.
N 4. Electrical Engineering Laboratory, 2.
Q 2. Hydraulics, 3-5.
R 4. Mining Engineering, 3-5.
Y 2. Stratigraphical Geology, 2-5.

PRINCIPAL OBJECT—CIVIL OR MINING ENGINEERING.

First Year—Seven and Four-fifths Courses.

A 1. Algebra, 1.
A 2. Plane Trigonometry, 2-5.
A 3. Spherical Trigonometry, 1-5.
A 4. Analytic Geometry, 4-5.
B 1. Physics, 1.
F 1. General Chemistry, 4-5.
F 2. Blowpipe Analysis, 1-5.
L 2. Topographical Drawing, 1-5.
Q 1. Surveying, 2.
R 1. Principles of Mining, 3-5.
V 1. Economic Botany, 1-5.
W 1. Crystallography, 1-5.
Y 1. Principles of Geology, 1-5.

Second Year—Seven and Four-fifths Courses.

A 5. Calculus, 1.
C 1. Analytic Mechanics, 2-5.
F 3. Qualitative Analysis, 4-5.
L 1. Mechanical Drawing, 1.
L 3. Topographical Drawing, 1-5.

M 1. Properties of Materials, 3-5.
M 2. Shop-Practice, 2.
R 2. Mine Surveying and Mining, 2-5.
R 3. Mine Surveying and Mining (Practice), 1.
V 2. Zoology and Palæontology, 2-5.

Third Year—Seven and Four-fifths Courses.

C 2. Analytic Mechanics, 2-5.
F 4. Quantitative Analysis, 1.
L 4. Graphical Statics, 2-5.
M 3. Mechanism, 2-5.
M 4. Mechanics of Materials, 1.
M 5. Mechanical Engineering, 1.
M 6. Testing Materials of Engineering, 1.
Q 2. Hydraulics, 3-5.
R 4. Mining Engineering, 3-5.
W 2. Mineralogy, 1.
Y 2. Stratigraphical Geology, 2-5.

Fourth Year—Eight and One-fifth Courses.

B 3. Electrical Measurements, 1.
G 1. Assaying, 2-5.
G 2. Metallurgy, 1.
L 5. Engineering Design, 3-5.
N 1. Electrical Engineering, 1.
R 5. Mine Management and Accounts, 2-5.
R 6. Mine Ventilation, 2-5.
S 1. Ore Dressing, 1.
X 1. Petrography, 1.
Y 3. Physical Geology, 2-5.
Y 4. Geological Field Work, 1.

ENTRANCE EXAMINATION QUESTIONS.

ARITHMETIC.

1. Simplify $\frac{3}{4}$ of $\frac{5}{7} \div \frac{3}{11}$ and give reasons for each step in the process.

2. Simplify $$\frac{\dfrac{2\frac{3}{4} - \frac{7}{8}}{3\frac{1}{2} + 1.25 - \frac{6}{10}}}{\dfrac{(\frac{15}{8} - \frac{8}{9}) \div 1\frac{5}{6})}{\frac{8}{11} \times \frac{17}{6}}}.$$

3. Extract the square root of 63.90684, and the cube root of .00016876.

4. Multiply thirty-seven and sixty-nine hundred thousandths by thirty hundredths and divide by thirteen ten thousandths. Explain the use of the decimal point in this case.

5. If one ton of ore containing $1\frac{1}{2}$ per cent copper is worth \$3.30, what is the price of copper per kilogram.

6. Find the present worth of \$600, due in two years, the rate of interest being six per cent.

7. Four men can do a piece of work in one hour which two women can do in three hours and six children in two hours. How long would one man, one women, and one child take to do the work? Give a full solution.

8. A bar of metal 6.3 meters long, 4 c. in. wide and $1\frac{1}{2}$ c. in. thick is cast into a cube, what is the length of one side of the cube? What would be the diameter if cast in the form of a sphere?

ALGEBRA.

1. (*a*) Add $\frac{1}{2}(\sqrt[3]{x^2} - y^{-\frac{1}{3}} + y^{-2})$ and $\frac{2}{3}(x^{\frac{2}{3}} + \frac{1}{\sqrt[3]{y}} - \frac{1}{z^2})$.

   (*b*) From $a + b + \sqrt{a - b}$ take $b + a - (a - b)^{\frac{1}{2}} + \sqrt{a\,b}$.

2. Multiply $m^4 + n^4 + o^4 - m^2\,n^2 - m^2\,o^2$ by $m^2 + n^2 + o^2$.

   (*a*) Multiply $a^4 + a^3\,y + a^2\,y^2 - a\,y^3 + y^4$ by $a^2 + 2\,a\,y + y^2$.

   (*b*) Divide $x + y + z - 3\,\sqrt[3]{x\,y\,z}$ by $x^{\frac{1}{3}} + y^{\frac{1}{3}} + z^{\frac{1}{3}}$.

3. Factor $m^6 - n^6$, $x^2 + ax - x - a$, $x^2 + 12x - 28$.

4. Simplify $\dfrac{\frac{a}{b^2} + \frac{b}{a^2}}{\frac{1}{a^2} - \frac{1}{ab} + \frac{1}{b^2}}$ also $\left(\dfrac{\sqrt[4]{a^3}\sqrt[3]{b^2}}{5\sqrt[4]{c^5}}\right) \div \left(\dfrac{2b^{\frac{3}{4}}}{5a^{12}\sqrt{b^2c^9}}\right)$ and explain steps in solution.

5. Solve $\dfrac{6x+7}{3} - \dfrac{3}{x+2} - (2x - \frac{1}{2}) = 0$.

GEOMETRY, PLANE.

Demonstrate the following propositions:

1. The sum of the angles of any plane triangle is equal to two right angles.

2. If two parallel lines are cut by a transversal, prove that the alternate exterior angles are equal.

3. If a line parallel to the base of a triangle bisects one side, it bisects the other side also.

4. In the same circle or equal circles, two angles at the center have the same ratio as the arcs which they subtend. (Two cases.)

5. The square on the hypothenuse of a right triangle is equivalent to the sum of the squares on the other two sides.

6. The area of a circle is equal to what? State and prove.

7. The ratio of the squares of the legs of a right triangle is equal to the ratio of the segments formed by dropping a perpendicular from the vertex of the right angle upon the hypothenuse.

8. Construct a rectangle the sum of whose base and altitude are equal to a given line, and whose area is equivalent to that of a given square.

GEOMETRY, SOLID AND SPHERICAL.

1. If a straight line is perpendicular to each of two other straight lines at their intersection, it is perpendicular to the plane of the two lines.

2. Every point in a plane which bisects a dihedral angle is equidistant from the faces of the angle.

3. The sum of any two face angles of a trihedral angle is greater than the third face angle.

4. The volume of a triangular pyramid is equal to one-third the product of the area of the base by the altitude.

5. The volume of a triangular pyramid is equal to one-third the volume of a triangular prism having the same base and altitude.

6. In two polar triangles each angle of one is measured by the supplement of the opposite side in the other.

7. The volume of a spherical pyramid is equal to the area of its base multiplied by one-third of the radius of the sphere.

8. A pyramid whose altitude is $\sqrt[3]{16}$ feet is cut into two parts of equal volume by a plane parallel to the base. Find the distance of the cutting plane from the vertex.

PHYSICS.

1. What are the laws of liquid pressure? Explain the Hydrostatic Press.

2. What is density? Give some good method of finding the density of an iron nut.

3. A block of wood weighs 33.5 grams in air. A sinker weighs 22.8 grams in water. Both together weigh 15.7 grams in water. Find the specific gravity of the wood.

4. Find the resultant and equilibrant of a pair of forces of 3 lbs. and 4 lbs. at right angles to each other.

5. A pin is placed in front of a mirror. Illustrate by means of a diagram how you would find the position of the image.

6. Explain fully sound wave vibrations.

7. Explain the sympathetic vibrations and the interference of sound waves, and give an example of each.

8. How would you test a Centigrade mercury thermometer?

9. Given the value of the latent heat of fusion of ice as 80 g. cs., and that of steam as 537 g. cs., how many gram calories will be necessary to change 500 grams of ice at 0 degrees to steam at 100 degrees C.

10. State the laws of magnets and describe how you would set up a Daniell cell.

BOOK-KEEPING.

1. What are the principal methods of book-keeping? Name and state object of books used in each.

2. State rules for debiting and crediting, bills payable, bills receivable, interest.

3. What is a trial balance and a balance sheet? When may an account be omitted from the trial balance?

4. Jan. 4. Bought of Moore & Co., Detroit, 2,000 bbls. flour at

$5.25. Gave in payment our check on German-American Bank for $4,000, Preston & Co.'s note for $5,000, discount to maturity allowed to Moore & Co. and cash for balance.

(a) What debits and credits will you make for this transaction? Why?

(b) What entries will Moore & Co., make? Why?

(c) What entry will the German-American Bank make when check is paid?

(d) Give the form of Preston & Co.'s note as originally received by you.

(e) Give the form of check on German-American Bank on Jan. 4.

In addition to questions of above character a record of supposed transactions is given to the candidate to enter in the proper names in the different books, and he is required to make his own rulings.

ASTRONOMY.

1. How are stars located in the heavens? Give two methods, defining terms used.

2. What are nebulæ, new, variable and double stars, and upon what evidence are based the views concerning them?

3. Explain and illustrate by diagram what is meant by the radius vector passing over equal areas in equal time.

4. Define Parallax; and describe a process of finding the moon's approximate distance from the earth.

5. Explain the difference between the four kinds of time.

6. Give the method of locating the position of a ship at sea, in the daytime.

7. What is the distance from the sun of an asteroid having a period of eight years?

8. Explain one method of finding the velocity of light.

9. State clearly the Nebular Hypothesis and give the evidence upon which it is based.

10. What is the general law of Gravitation?

In applying this law to the relation of the earth to other bodies, what is taken as the unit of measure?

ENGLISH COMPOSITION.

Comets. Give a clear account of them, that shall be correct in punctuation, spelling and in the use of the English language.

Undulatory Theory of Light. Give a clear statement of this theory and the evidence in favor of it.

LIBRARY.

The Library of the School contains at present 11,353 volumes, and some 1,700 pamphlets, not including school catalogues. The 1,194 volumes added since the last issue of the Catalogue have been acquired as follows:

	GIFT.	PURCHASE.	BINDING.
1894-95	262	87	102
1895-96	233	238	272
Total	495	325	374

It will thus be seen that a large per cent of the accessions have been obtained through the courtesy of various societies. (books, etc.)

Books added by purchase relate strictly to the technical subjects taught in the school, and the instructors find the library indispensable in presenting their subjects. Because of the use made of a library of this kind, it becomes a necessity to have on hand records of the latest researches in science; hence an effort is made to secure books needed for the various departments as soon as they appear. This necessity is doubled when we remember that there is no other library in the town or vicinity to which those in search of such special literature can apply.

The library is intended to supplement class-room instruction throughout the school. Constant reference is made in classes to works contained in the library, and their study is encouraged.

The efficiency of the library depends largely upon the completeness of its files in important scientific and technical journals; to this end missing numbers and portions of sets which are lacking are supplied as fast as the school funds permit. It is especially desirable that the library should be rich in reports and works relating to Mining and the Mineral industry in this and other Mining regions of the world.

Contributions of books, pamphlets, maps, etc., bearing on the subjects taught are earnestly solicited and grateful acknowledgment is made of all such material received.

During the past year the library has been moved to the second floor of Science Hall, and occupies commodious, well-lighted quarters. The work on the card catalogue is continued.

A large collection of pamphlets, accumulated during past years, has been so arranged and classified as to be readily accessible, thereby greatly enhancing their value.

The library is open daily throughout the entire year, Sundays and legal holidays excepted, for the use of students and the public, under proper restrictions.

The Reading Room in connection with the library is supplied with the leading newspapers, scientific periodicals, journals, proceedings and transactions of societies. Heretofore all current publications of this kind were kept on file in the reading room, students having free access to them. The result was that great difficulty was experienced in keeping volumes complete for binding. This difficulty has been obviated and the school saved needless expense by placing on the library shelves all material intended for binding and preservation, and issuing such to the students only upon application.

A list of the publications received by the library, numbering 246 is appended.

PERIODICALS.

†Academische Revue, Munich.
American Chemical Journal, Baltimore.
American Engineer and Railroad Journal, New York.
†American Geologist, Minneapolis.
American Journal of Mathematics, Baltimore.
†American Journal of Science, New Haven.
American Machinist, New York.
†American Naturalist, Philadelphia.
*American Pythian, Grand Rapids.
†American School Commissioner, Chicago.
†Annalen der Chemie, Justus Liebig's, Leipzig.
†Annalen der Physik und Chemie, Leipzig.

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†A complete set of this publication is in the library.
*Gift of publishers.

†Annalen der Physik und Chemie, Beiblätter, Leipzig.
Annalen des k. k. naturhistorischen Hofmuseums, Wien.
†Annales des Mines, Paris.
†Annals of Mathematics, University of Virginia.
*Ann Arbor Physician and Surgeon, Detroit.
Anthony's Photographic Bulletin, New York.
*Appleton (D.) & Co.'s Monthly Bulletin.
†Astrophysical Journal, Chicago.
Atlantic Monthly, New York.
Berg-und huettenmaennisces Jahrbuch, Vienna.
Berg-und huettenmaennische Zeitung, Leipzig.
†Berichte der deutschen chemischen Gesellschaft, Berlin.
*Book Reviews, The Macmillan Co., Mew York.
†Builder, London.
Bulletin of the American Mathematical Society, New York.
†Bulletin de la Société Chimique de Paris.
†Bulletin of the Essex Institute, Salem, Mass.
†Bulletin de la Société Française de Minéralogie, Paris.
Bulletin of the Geological Institute of the University of Upsala.
†Bulletin of the Geological Society of America, Rochester, New York.
†Bulletin de la Société Géologique de France, Paris.
†Bulletin of the University of California, Berkeley, California.
*Bulletins of the Helena Public Library, Helena, Mont.
†Bulletin of the University of Wisconsin, Madison, Wisconsin.
*Canadian Engineer, Toronto.
Canadian Mining Review, Ottawa.
†Cassier's Magazine, New York.
Century Magazine, New York.
Chemical News, London.
Chemiker Zeitung, Cöthen, Germany.
Die chemische Industrie, Berlin.
*Chicago Mining Review, Chicago.
Civilingenieur, Leipzig.
Colliery Engineer, Scranton, Penn.
Colliery Guardian, London.
Colliery Manager, London.
†Comptes Rendus, Paris.
Cosmopolitan, New York.

Der Technicker, New York.
†Dingler's polytechnisches Journal, Stuttgart.
Electrician, London.
†Electrical Engineer, New York.
Electrical World, New York.
Electrotechnische Zeitschrift, Berlin.
Engineer, London.
†Engineering, London.
†Engineering Magazine, New York.
Engineering Mechanics, New York.
†Engineering and Mining Journal, New York.
†Engineering News, New York.
Engineering Record, New York.
*Field Columbian Museum, Publications of, Chicago.
The Forum, New York.
†Geographical Journal, London.
†Geological Magazine, London.
*Good Health, Battle Creek.
Harper's Magazine. New York.
*Harvard University Bulletin, Cambridge, Mass.
*Helios: Export Journal for Electrical Industry.
*Hochschule Nachrichten.
*Home Study, Scranton, Pa.
Industries and Iron.
Iron Age, New York.
*Iron Trade Review, Cleveland.
†Jahrbuch der k. k. geologischen Reichsanstalt, Vienna.
†Jahrbuch für das Berg-und Hüttenwesen, Freiberg.
†Jahresbericht ueber die Fortschritte der Chemie, Braunschweig, Germany.
†Jahres-Bericht Ueber die Leistungen der chemischen Technologie (Wagner's), Leipzig.
*Johns Hopkins University Circulars, Baltimore.
Journal de Physique, Paris.
Journal für praktische Chemie, Leipzig.
Journal of Education, Boston.
†Journal of the Association of Engineering Societies, Chicago.
†Journal of the Chemical Society, London.
Journal of the Franklin Institute, Philadelphia.

†Journal of Geology. Chicago.
Journal of Pure and Applied Mathematics, London.
Journal of the Society of Arts, London.
Journal of the Society of Chemical Industry, London.
Journal of the Iron and Steel Institute, London.
†*Journal of the Western Society of Engineers, Chicago.
*Kritischer Vierteljahresbericht ueber die berg- & hüttenmännische und verwandte Literatur, Freiberg.
L'Eclairage Electrique, Paris.
Le Génie Civil, Paris.
Library Journal, New York.
†Library Notes, Boston.
*Literary News, New York.
†London, Edinburgh and Dublin Philosophical Magazine, London.
Mathematical Magazine, Washington.
†Memoirs of the American Academy of Arts and Sciences, Boston.
McClure's Magazine, New York.
Michigan School Moderator, Lansing.
Mineralogical Magazine and Journal of the Mineralogical Society, London.
*Mining, Spokane Falls, Wash.
Mining and Scientific Press, San Francisco.
†Nature, London.
†Neues Jahrbuch fur Mineralogie, Geologie und Palaeontologie, Stuttgart.
Oesterreichische Zeitschrift für Berg-und-Hüttenwesen, Vienna.
*Official Gazette of the United States Patent Office, Washington.
†Petermann's Mittheilungen aus Justus Perthes' geographischer Anstalt, Gotha.
†Philosophical Transactions of the Royal Society of London.
Physical Education, Springfield, Mass.
†Physical Review, New York.
†Popular Science Monthly, New York.
Power, New York.
†Proceedings of the Academy of Natural Sciences, of Philadelphia.
†Proceedings of the American Academy of Arts and Sciences, Boston.
†Proceedings and Transactions of the American Society of Civil Engineers.

†Proceedings of the Boston Society of Natural History, Boston.
Proceedings of the Geologists' Association, London.
†Proceedings of the Institution of Civil Engineers, London.
†Proceedings of the Institution of Mechanical Engineers, London.
Proceedings of the London Mathematical Society, London.
*Proceedings of the Rochester Academy of Science, Rochester, New York.
†Proceedings of the Royal Society, London.
Publishers' Weekly, New York.
†Quarterly Journal of the Geological Society, London.
Review of Reviews, New York.
†Revue Universelle des Mines, de la Métallurgie, etc., Paris.
*St. Andrews' Cross, New York.
†School of Mines Quarterly, New York.
†Science, New York.
†Science Progress, London.
Scientific American, New York.
†Scientific American Supplement, New York.
Scribner's Magazine, New York.
†Sitzungsberichte der kaiserlichen Akademie der Wissenschaften, Vienna.
†Sitzungsberichte der königlich-preussischen Akademie der Wissenschaften zu Berlin.
Société Géologique de France, Compte Rendu, Paris.
Stahl und Eisen, Düsseldorf.
*Stone, Chicago.
†Transactions of the American Institute of Electrical Engineers, New York.
†Transactions of the American Institute of Mining Engineers, New York.
†Transactions of the American Society of Mechanical Engineers, New York.
*Transactions of the Canadian Institute, Toronto.
*Transactions of the Association of Civil Engineers of Cornell University, Ithaca, N. Y.
†Transactions of the Federated Institute of Mining Engineers, Newcastle-on-Tyne, England.
Transactions of the Manchester Geological Society, Manchester, England.

†Transactions of the Wisconsin Academy of Arts, Sciences and Letters. Madison, Wis.
†Verhandlungen der k. k. geologischen Reichsanstalt, Vienna.
†Zeitschrift der deutschen geologischen Gesellschaft, Berlin.
†Zeitschrift für analytische Chemie, Wiesbaden.
†Zeitschrift für anorganische Chemie, Leipzig.
†Zeitschrift für das Berg-Hütten-und Salinenwesen, Berlin.
†Zeitschrift für Krystallographie und Mineralogie, Leipzig.
†Zeitschrift für physikalische Chemie, Leipzig.
†Zeitschrift für praktische Geologie, Berlin.

NEWSPAPERS.

* Alpena Pioneer.
*Ann Arbor Argus.
*Ann Arbor Courier.
*Bay City Tribune.
*Belleville Enterprise.
*Bellevue Gazette.
*Bessemer Herald.
*Boise City (Idaho) Statesman.
*Bronson Journal.
*Cadillac State Democrat.
*Calumet Conglomerate.
*Calumet Copper Country Evening News.
*Calumet and Red Jacket News.
*Capac Journal.
*Chicago Herald.
*Church Helper of Western Michigan.
*Coldwater Sun.
*Coldwater Weekly Courier.
*Crystal Falls Diamond Drill.
*Detroit Evening News.
*Detroit Free Press.
*Detroit Journal.
*Ely Times.
*Escanaba Iron Port.
*Escanaba Journal.
*Escanaba Mirror.

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* Gift of the publishers.

*Ewen Recorder.
*Fife Lake Monitor.
*Flint Evening Journal.
*Florence Mining News.
*Grand Rapids Democrat.
*Grand Rapids Workman.
*Grand Traverse Herald.
*Hancock Semi-Weekly Copper Journal.
*Hancock Progress.
*Houghton Portage Lake Mining Gazette.
*Imlay City Record.
*Iron River Iron County Reporter.
*Ironwood News-Record.
*Ironwood Times.
*Ishpeming Iron Ore.
*Ishpeming Peninsular Record.
*Jackson Weekly Patriot.
*Kalamazoo Daily Telegraph.
*Kalkaskian.
*L'Anse Sentinel.
*Lake Linden Native Copper Times.
*Lansing Republican.
*Lapeer Clarion.
*Manistee Advocate.
*Manistee Daily News.
*Manistique Tribune.
*Manistique Semi-Weekly Pioneer.
*Maple Rapids Dispatch.
*Marquette Mining Journal.
*Menominee Democrat.
*Menominee Herald.
*Stephenson Menominee County Herald.
*Michigan Maccabee.
*Milan Leader.
*Negaunee Iron Herald.
*New York Times.
*Norway Current.
*Ontonagon Herald.
*Ontonagon Miner.

*Owosso Press.
*Petoskey Independent Democrat.
*Petoskey Record.
*Pontiac Gazette.
*Pontiac Oakland County Post.
*Port Huron Bee Hive.
*Port Huron Weekly Times.
*Romulus Roman.
*Saginaw Evening News.
*Saginaw Weekly Courier-Herald.
*Sault Ste. Marie Democrat.
*Sault Ste. Marie News.
*St. Clair Republican.
*St. Ignace News.
*Traverse Bay Eagle.
*Traverse City, Grand Traverse Herald.
*Vassar Times.
*Virginian.
*Virginia Enterprise.
*Willis Times.
*Youths' Instructor.
*Ypsilantian.

REGULATIONS OF THE LIBRARY.

1. *Hours:* The Library is open daily throughout the year except Sundays and legal holidays from 8 A. M. to 6 P. M.

2. *Access:* Students are not allowed access to the shelves except through special permission obtained from the Librarian.

3. *Reference Books:* Reference books are not to be taken from the building except by special permission from the Librarian.

4. *Time:* Books may be held by the students for two weeks, and renewed at the end of that time if desired, unless previously asked for by another.

5. *Ticket:* A ticket is to be deposited with the Librarian for every book and periodical taken from the Library.

6. *Books Lost or Injured:* Books lost or injured are to be replaced or repaired at the expense of the person to whom they were issued.

7. *Books Called in:* Books may be called in by the Librarian at any time.

8. *Fines:* Keeping books beyond the allotted time will entail a fine of five cents per day for each book overdue, and will forfeit the privilege of renewing or taking any other books, until the fines are paid.

9. *Use of Library:* Members of the Board of Control, officers of the State Geological Survey, the chief officers of mines, stamp mills and smelting works, superintendents and principals of graded schools, resident clergymen, and resident officers in the service of the State or the United States, and officers and students of the Mining School can take out books under the usual regulations herein provided. All other persons on the recommendation of the Director and Librarian, can take out books under the usual condition, after making a deposit of $5, with the Treasurer, or in case of books of special value, a deposit sufficient to cover the cost. The Treasurer's receipt is to be exhibited to the Librarian before any book is to be taken out by the party in question.

10. *Use in Reading Room:* Books may be taken out by any one for use in the Reading Room, at the discretion of the Librarian.

COLLECTIONS.

The distinctive purpose of the Mining School has been to arrange its collections for their value and use in teaching and not for exhibition or show. For this reason only minor portions of the materials belonging to the school are placed in exhibition cases for the benefit of the general public. Most of the collections are kept in drawers and cases, in the laboratories where the student has, as a rule, as free access to them as the instructors themselves. This is done in order that they shall be of the greatest benefit to the students, the parties in whose interests the Mining School was organized and for whose benefit it is conducted.

The collections now in the possession of the school for the purpose of illustration and study are the following:

Biological Collections	800
Palæontological Lecture Collections	790
Palæontological Practice Collection	3,100
Collection of Glass Crystal Models	151
Collection of Wooden Crystal Models	2,153
Collection of Natural Crystals	2,260
Collection Illustrative of Physical Properties of Minerals	485
Lecture Collection of Minerals	10,000
Practice Collection of Minerals	17,025
Exhibition Collection of Minerals	1,000
Emerson Collection of Minerals	550
Thin Sections of Minerals	2,000
Polariscope Sections of Minerals	132
Lecture Collection of Rocks	3,800
Practice Collection of Rocks	6,500
Rosenbusch Collection of Rocks	1,000

Lecture Collection of Michigan Rocks	675
Practice Collection of Michigan Rocks	1,300
Stratigraphical Rock Collections	210
Thin sections of Rocks	4,973
	66,014

Besides the above, there are collections of palæontological charts, metallurgical, geological, and petrographical diagrams, geological models, maps, metallurgical collections, etc.

Collections of slags, metallurgical products, materials for illustration in Economic Geology, as well as some exhibition collections, have been commenced and all persons, particularly former students and graduates of the school, who can, are urged to contribute to the school collections of minerals, rocks, veinstones, ores, slags, metallurgical products, samples of building stones, machinery, tools, etc., and models, photographs and prints of the same, etc.

In the case of mineral products used in arts and manufactures, it is desired to procure specimens showing the various stages in the process of manufacture. It is especially important for the School to receive and preserve sets of cores from drill holes, samples of ores from every mine, with specimens of the associated gangue minerals and rocks, as well as of the walls and associated country rocks.

If the graduates and other former students of the Mining School would see to it that the materials desired were sent to the school from their respective localities, they would do some little toward repaying the heavy debt that they owe to the State of Michigan in generously giving them their education free of charge.

PRIZES AND SCHOLARSHIPS.

THE LONGYEAR PRIZES.

Through the liberality of Hon. J. M. Longyear, of Marquette, the following prizes have been offered, as stated in his letter which is here appended:

Marquette, Michigan, Nov. 9, 1887.

CHARLES E. WRIGHT, ESQ., MARQUETTE:

DEAR SIR—I wish to offer three first prizes of seventy-five dollars ($75) each, and three second prizes of fifty dollars ($50) each, to be competed for by the members of the senior class of the Michigan Mining School. The competition to be by means of papers on three subjects, written by members of the class, and submitted to the Board of Control for examination in such a manner and a such a time as the Board may determine. I desire subjects selected with a view of producing papers which will be of practical use in developing the mineral resources of the State of Michigan. I should like something which would be of service to the average woodsman or explorer, and suggest the subjects of Practical Field Geology, and the use of the Dial and Dip Compass; in explorations leaving the selection of the third subject to the judgment of the Board. If this offer is accepted, and there are two or more papers on each subject submitted, I will pay seventy-five dollars to each of the writers of the three papers which may be awarded the first prizes, and fifty dollars to each of the writers of the three papers which may be awarded the second prizes.

I would suggest, however, that in case only two papers are submitted, that the Board reserve the right of awarding only one prize, in case such action should seem advisable. In case only one paper should be submitted, I should like the Board to exercise its judgment in awarding a prize. It is my desire to publish the papers under the writers' names, in pamphlet form, for distribution among miners, explorers, land owners, and others.

Yours very truly
J. M. LONGYEAR.

In conformity with the foregoing letter, the Board of Control have decided upon the following subjects and conditions:

Subjects.

1. Field Geology; its Methods and their Applications.
2. The Dial and the Dip Compass and their Uses.
3. The Diamond Drill and its Uses.

Conditions.

The conditions under which the prizes are awarded are as follows:

The papers are to be presented by June 1st, for each year.

A student may present a paper upon each of the three subjects, which will entitle him to three prizes, if his papers are found worthy.

The dissertations must be prepared in the same manner as the theses, the regulations for which can be procured on application to the Secretary of the school.

The title page is to have upon it an assumed name, and each dissertation is to be accompanied by a sealed envelope bearing the same name. This envelope must contain the writer's true, as well as assumed, name, and his address, and it will not be opened until the awards have been made.

No prizes will be awarded, unless the papers are judged by the committee to whom they are referred, to be of a sufficiently high standing to be entitled to a prize; hence, there may be awarded all, part, or none of the prizes, as the case may be.

These prizes can now be competed for by any students of the school, whether special, graduate or regular, without restriction to the graduating class, as was originally specified.

THE CHARLES E. WRIGHT SCHOLARSHIP.

The Charles E. Wright Scholarship has been founded by Mrs. Carrie A. Wright, of Ann Arbor, in accordance with the conditions expressed in the letter given below:

To the Honorable Board of Control of the Michigan Mining School:

GENTLEMEN—In memory of my husband, the late Charles E. Wright, and as a token of the deep interest he had in the Michigan

Mining School, I desire to give to said school the sum of one thousand dollars.

If said gift shall be accepted, it is to be held under the following conditions, to-wit: It is to be invested as a permanent fund, by the Board of Control, to form the nucleus of a scholarship to be known as the Charles E. Wright Scholarship. The income is to be given to some indigent student, by vote of the Board of Control, with the advice and consent of the Faculty of said school.

The award is to be made during the first term of the year, to some student who has a satisfactory record during the entire preceding year in the Michigan Mining School, and who intends to devote himself to the profession of Mining Engineering or Geological work. The income is to be divided into three equal parts, to be paid during the three terms of the year, and if at any time the conduct or standing of the student receiving the award should become unsatisfactory, the portion then remaining unpaid should be withheld from him, and given to some other student, in accordance with the terms of this gift.

(Signed) CARRIE A. WRIGHT.

THE NORRIE SCHOLARSHIP.

This scholarship has been founded, and will be awarded in accordance with the conditions and requirements stated below:

Know all men by these presents, That I, A. Lanfear Norrie, of the city of New York, hereby give, grant, assign, and set over unto, the Michigan Mining School, of Houghton, Michigan, and to Peter White, D. H. Ball and J. M. Longyear, of Marquette, Michigan, as trustees, the sum of five thousand dollars ($5,000), lawful money of the United States.

The conditions of this gift, and upon which this fund is to be taken, are that the said trustees shall invest the same upon bond and mortgage in the village of Marquette, or in the city of Detroit, in the State of Michigan, or in the city of Milwaukee, in the State of Wisconsin, or in the city of Chicago, in the State of Illinois, upon unencumbered improved real estate.

That one-half of the income of said sum of $5,000 shall be paid yearly by said trustees unto the Board of Control, for the support of some student whose father has worked in, or in some way been connected with, mining operations in the Upper Peninsula of Michigan, who shall be designated by the Faculty of said school; and the remainder of said income shall be accumulated and invested as said principal shall be invested, and that this fund with its accumulations shall be the basis of a larger fund, to be obtained from other contributions, amounting to at least one hundred thousand dollars ($100,000), to be used for the erection of a Dormitory Building, for the use of such students as shall be designated by said Faculty; which building, when erected, shall be under the exclusive control of the corporation or Board of Control of the said Michigan Mining School

This gift is to the said trustees and their successors forever, for the benefit of the said Mining School. In case of the death of either of said trustees, the survivors or survivor shall appoint a successor or successors.

When the erection of said building shall be commenced, after the said fund of one hundred thousand dollars is obtained, the sum hereby given, with all its accumulations, shall be paid over to the said Mining School, for the purpose aforesaid.

Witness my hand, the 30th day of January, 1890.

A. LANFEAR NORRIE.

Witness, T. E. O. M. STETSON.

We, Peter White, D. H. Ball and J. M. Longyear, the persons named in the above instrument, accept the trust therein granted, in all respects, and agree to comply with the conditions thereof.

Witness our hands, the 1st day of February, 1890.

PETER WHITE,
D. H. BALL,
J. M. LONGYEAR.

THE LONGYEAR FUND.

This is a fund of $500.00 a year given for several years by Hon. J. M. Longyear of the Board of Control, to be the property of the Mining School, to be loaned to students of said School who may be designated by the Director and Treasurer, said students being unable to maintain their connection with the School without such aid.

This money is not to be a gift to the student, but he is to pay it back as soon as practicable after graduation. After his graduation interest will be charged him for the first three years at 5 per cent, and for the following two years at 7 per cent. The money and the interest are to go to the fund, to aid other students in the same way. This method, it is believed, will lead the student to a more manly feeling than a gift outright would produce in him, since it gives him the means of paying for his own education, assists him when he most needs assistance, and enables him to return the money to aid others, at a time when he can best do so.

It is believed that it would be better if all funds given to the School for investment and use, should be accompanied by some proviso that a certain portion, at least, of the income shall be saved or set aside, to increase the principal until it shall attain a limit, either fixed, or left to the proper authorities to determine. Such a method would enable the institution in the future to do much more good, than it would if the income were to be spent entirely each year.

The School is in great need of funds to aid students who would otherwise be unable to attend its classes. Aid of this kind is frequently sought by able and worthy young men, and all is done that can be, with the limited means at the command of the School to assist them.

The Longyear Fund has been continued for four years, and now amounts to $2,000.00, and part of it is at present available.

BENEFICIARIES OF SCHOLARSHIPS AND FUNDS.

Norrie Scholarship.

Robert Murray, Jr.	1894–1895

Longyear Fund.

Arthur Walter Bates	**1895–1896**
Appleton Richey	**1895–1896**
Ralph Clark Works	**1895–1896**

BUILDINGS.

SCIENCE HALL, or the main building now occupied by the Mining School, was completed by the State in 1889, at a cost of $75,000. The building is constructed of Portage Entry sandstone, with a tile roof (see Frontispiece).

The larger part of the site and grounds was donated to the School by the Honorable Jay A. Hubbell, to whom the establishment of the School is chiefly due. The building has a large and independent supply of spring water, sufficient for all its present needs.

The main building is 109 feet by 53 feet, with a wing 37 feet by 25 feet. The interior portion of the building has been arranged so as to save the greatest amount of space possible for the laboratories and working rooms, consistent with safety to the structure and proper light. The halls have been reduced to a minimum. The size of the rooms and their uses are here given:

SCIENCE HALL.

BASEMENT.

Students' Room	16x33 feet.
Gymnasium	31x42 feet.
Store Room	14x19 feet.
Carpenter Shop	31x42 feet.
Assaying Laboratory	32x41 feet.
Weighing Room	13x16 feet.
Lavatory	8x11 feet.

FIRST FLOOR.

Laboratory of Economic Geology	22x27 feet.
Palæontological Laboratory	21x27 feet.
Professor's Room	15x21 feet.
Geological Laboratory	21x27 feet.

Mineralogical Laboratory	27x40 feet.
Petrographical Laboratory	24x33 feet.
Goniometer Room	7x16 feet.
Lavatory	13x16 feet.
Coat Room	6x16 feet.

SECOND FLOOR.

Library	29x49 feet.
Reading Room	14x21 feet.
Recitation Room	15x26 feet.
Recitation Room	14x21 feet.
Recitation Room	28x32 feet.
Professor's Room	14x16 feet.
Physical Laboratory	33x41 feet.
Lavatory	13x16 feet.

THIRD FLOOR.

Balance Room	13x16 feet.
Quantitative Laboratory	43x32 feet.
Professor's Room	15x26 feet.
Qualitative Laboratory	43x49 feet.
Chemical Lecture Room	24x33 feet.
Spectroscope Room	6x16 feet.
Chemical Supply Room	15x16 feet.
Chemical Supply Room	11x13 feet.

TOWER.

Professor's Room	15x26 feet.
Photographic Laboratory	15x19 feet.

ENGINEERING HALL.

This building was erected in 1893–1894, and first occupied in the summer of the latter year. (See plate at the end of this catalogue.) The size of its rooms and their uses are subjoined:

BASEMENT.

Machine shop	97x24 feet.
Tool Room	5x17 feet.
Electrical Instrument Room	34x17 feet.
Dynamo Room	34x27 feet.

Lavatory	28x10 feet.
Photometer Room	8x14 feet.

FIRST FLOOR.

Pattern Shop	70x25 feet.
Lecture Room	28x26 feet.
Laboratory for Testing Materials	27x25 feet.
Oil Testing Room	18x 9 feet.
Tool Room	11x 8 feet.
Lavatory	12x12 feet.
Professor's Office	16x13 feet.
Stock Room	18x 9 feet.
Storage Battery Room	15x11 feet.

SECOND FLOOR.

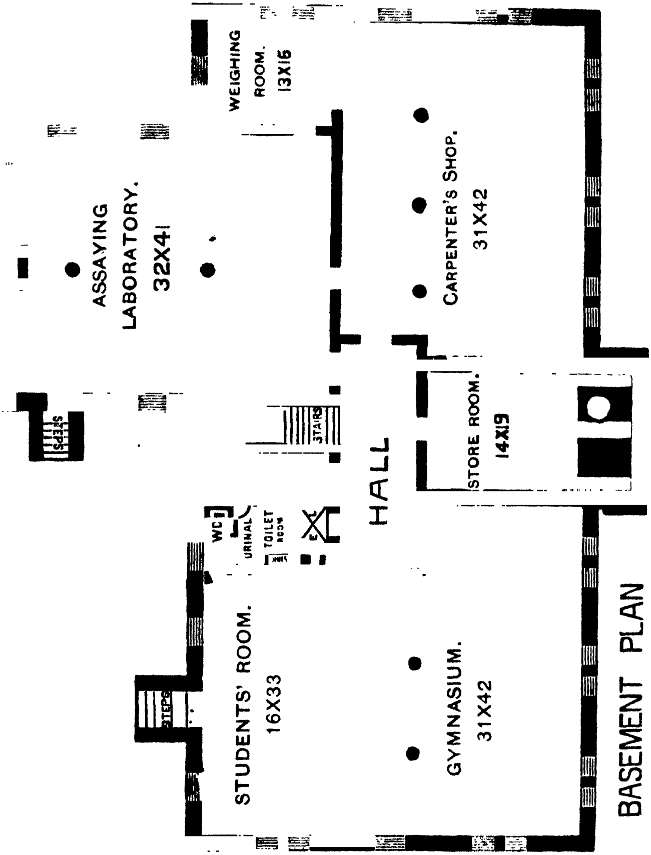
Drawing Room	97x25 feet.
Blue Print Room	12x 8 feet.
Lecture Room	35x28 feet.
Assistant's Office	12x11 feet.
Office of Mining Department	16x15 feet.
Map Room	15x12 feet.
Lavatory	11x11 feet.

An annex contains a Fuel Room 16x34 feet, and a Boiler Room 29x34 feet. In the latter are located three boilers, two of which are used for heating purposes. To enable the student to become practically familiar with water tube boilers, a 58 HP Stirling water tube boiler is used to supply steam to shop, laboratory and stamp mill engines.

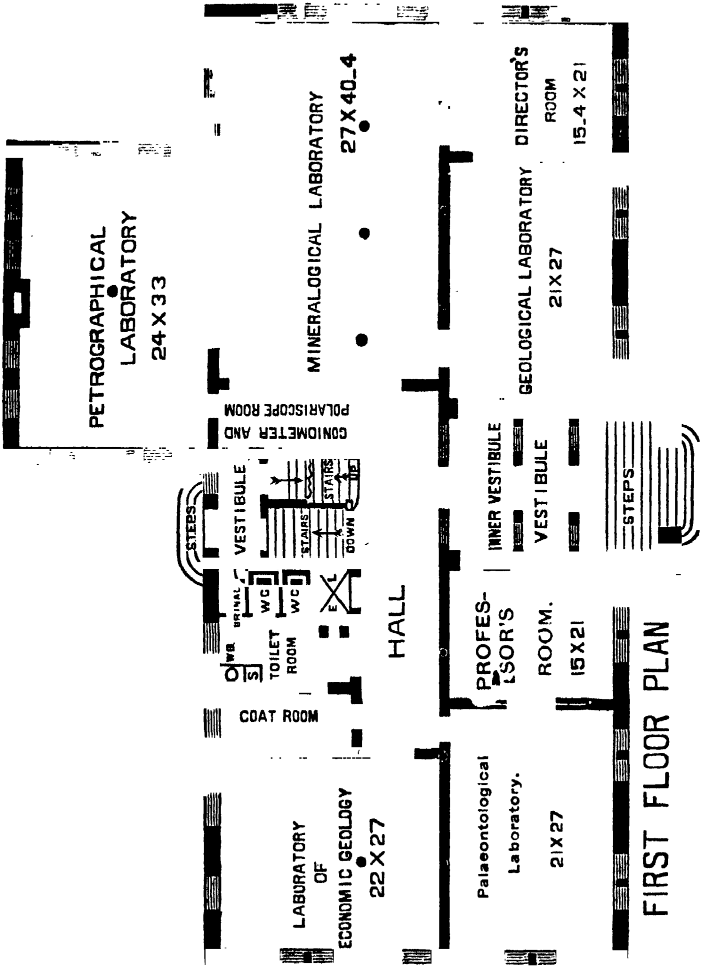
Besides the two principal buildings the School has also erected for its use other structures as follows:

Ore Dressing Plant or Stamp Mill	81x30 feet.
Roasting Furnace Building	28x28 feet.
Oil House	22x20 feet.
Storage House	46x25 feet.

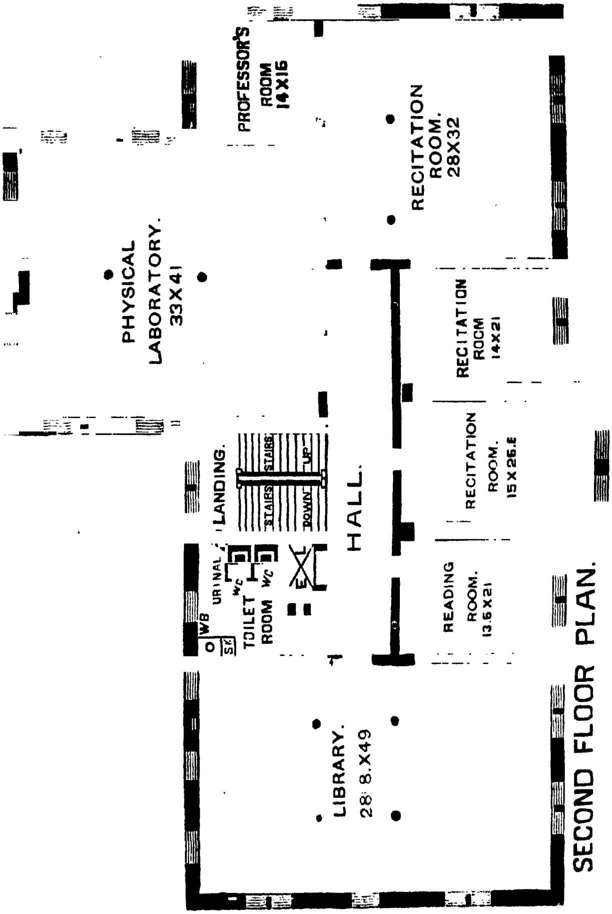
The floor plans of Science Hall are appended.



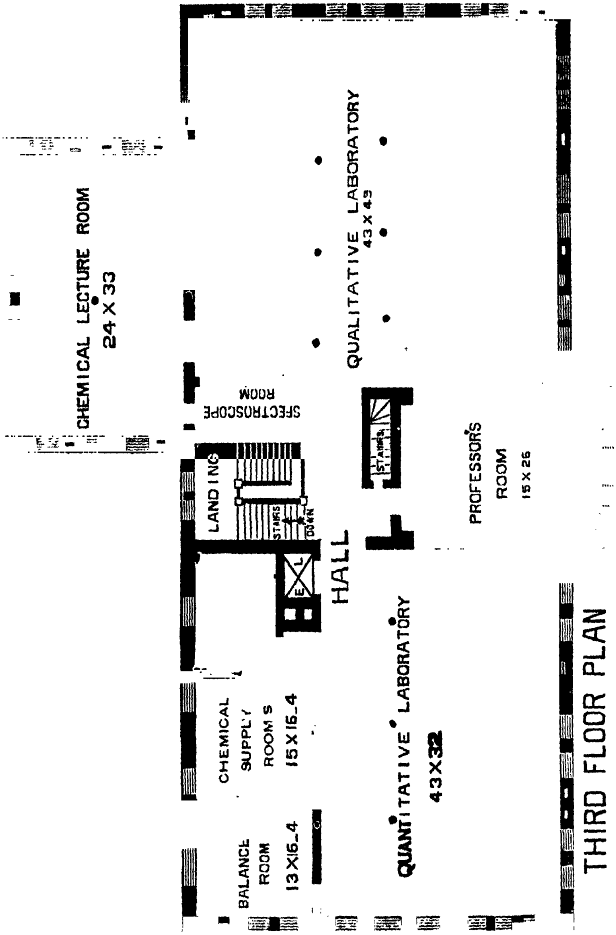
BASEMENT PLAN



FIRST FLOOR PLAN



SECOND FLOOR PLAN.



THIRD FLOOR PLAN

DEPOSITS, TUITION AND OTHER EXPENSES.

Under the act of organization, the Board of Control has made the school entirely free, no charge being made for tuition or incidentals, whether the student is a resident of the State of Michigan, or of the United States, or not; students from every land, under the broad, enlightened and liberal policy of the State, are cordially invited to make the fullest use of the educational advantage offered by this institution.

The supplies in the chemical and allied laboratories are furnished the students, and they are required to pay for materials, re-agents, etc., and for the use and breakage of apparatus, but there is no difference made between residents of the State and non-residents.

All students working in the Chemical Laboratories are required to pay ten dollars a year, which general charge covers all chemicals, gas, use of balances, etc. Students taking the course in Assaying are required to pay eight dollars for materials consumed.

In order partially to insure the State against damage and loss to its school property, every student is required to deposit with the Treasurer the sum of twenty-five dollars ($25). This sum shall not be withdrawn by the student until he closes his connection with the School; and if any portion is required by the School as a refund for damages, the part withdrawn shall be at once replaced by the student, or he shall stand dismissed from the institution.

Charges for apparatus, chemicals and other supplies from the store room, as well as for repairs of damages to school property, and also fines, shall be deducted from coupons procurable from the Clerk upon payment of five dollars each, but no portion of the twenty-five dollars above mentioned shall be used for the purchase of these coupons. The permanent deposit of twenty-five dollars, together with any balance equivalent to the unused portion of a coupon, shall be returned to the student when he closes his connection with the school, but not before.

There are no dormitories connected with the School. Arrangements can be made by those who desire to do so, to obtain board and rooms in private families, and in boarding houses, in Houghton and Hancock, at prices varying from twenty to twenty-five dollars per calendar month. Twenty-two or twenty-three dollars per month is understood to be the standard average price. This is to include the room, heat and lights, as well as board. Board alone can be obtained at from seventeen to twenty dollars per calendar month.

The expenses of course vary much with the taste and habits of the student, but when it is considered that he is given gratuitously instruction of a grade and with an equipment that he cannot obtain elsewhere except upon the payment of from $100.00 to $200.00 tuition fee, the average expenses seem very low.

Students have assured the Director that during the forty-five weeks in the school year their entire expenses were within $200.00. This small expense can of course be obtained only by self board or by boarding in clubs.

In averaging the expenses of the students the data given below have been furnished by the students to one of their own number who was interested in collecting the statistics. They can be relied upon, therefore, as being as accurate as it is possible to obtain. In comparing these expenses with those at other institutions, it is to be remembered three years of forty-five weeks at the Mining School are the equivalent of the usual four years of most other institutions; while if a sudent remains here only the ordinary thirty-four weeks of a school year, he can proportionately diminish his expenses so that they will be only about two-thirds of the amounts given in the table of expenses.

ANNUAL EXPENSES OF STUDENTS IN THE MICHIGAN MINING SCHOOL FOR FORTY-FIVE WEEKS OF ACTUAL SCHOOL WORK.

EXPENSES FOR STUDENTS.	LOW.	MEDIUM.	HIGH.
Board (Forty-five Weeks)	$175 00	$190 00	$225 00 +
Room (Eleven Months)	11 00	55 00	65 00 +
Washing, etc. (Eleven Months)	15 00	25 00	30 00 +
Books	25 00	29 00	38 00 +
Laboratory Expenses	15 00	25 00	30 00 +
Incidental Expenses (Mining Trips, etc.)	10 00	13 00	25 00 +
Extra Expenses in Mining, Surveying, or Field Geology	10 00	50 00	65 00 +
Total Annual Expenses	$261 00	$387 00	$478 00 +
Average Weekly Expenses	$5 80	$8 60	$10 62 +

ORGANIZATION AND GOVERNMENT.

The Michigan Mining School is an institution established and supported by the State of Michigan, in accordance with that liberal educational policy which has placed its educational institutions among the foremost of America.

The Mining School is organized under the authority of an Act, approved May 1, 1895, portions of which are as follows:

"SECTION 1. The people of the State of Michigan enact: That a school shall be established in the Upper Peninsula of the State of Michigan, to be called the Michigan Mining School, for the purpose and under the regulations contained in this Act.

"SEC. 2. The said school shall be under the control and management of a board of six members, not less than four of whom shall be residents of the Upper Peninsula of the State of Michigan, who shall be known as the Board of Control of the Michigan Mining School, and who shall be appointed by the Governor of the State of Michigan, by and with the consent of the Senate, * * * * and who shall serve without compensation.

"SEC. 5. The course of instruction shall embrace geology, mineralogy, chemistry, mining and mining engineering, and such other branches of practical and theoretical knowledge as will, in the opinion of the board, conduce to the end of enabling the students of said Institution to obtain a full knowledge of the science, art and practice of mining, and the application of machinery thereto. Tuition shall be free in said Institution, to all *bona fide* residents of this State, but a reasonable charge for incidental expenses, not less than ten dollars nor exceeding thirty dollars per year, may be made against any student, if deemed necessary, and the board shall not be obliged to furnish books, apparatus, or other materials for the use of students.

"SEC. 6. The course of study, the terms, and the hours of instruction, shall be regulated by the board, who shall also have power to make all such rules and regulations concerning admission, control and discipline of students, and such others, as may be deemed necessary for the good government of the Institution and the convenience and transaction of its business.

"SEC. 7. No debt shall be contracted beyond or apart from the actual means at the disposal of the Institution. The board may dispose of, or lease any property donated to the State for said School, or which may be acquired in payment of debts except of such as is necessary for the accommodation of the school. * * * * "

In conformity with the above act, the Michigan Mining School was first opened to students September 15, 1886, and has been made free to students from every land. All are received on the same conditions.

Further, the school has never contracted any debt in advance of the means at its disposal, and has all its property clear.

The Board assumes general oversight over all expenses, all employees of the Institution, and all its general interests; the Director has general charge of the course of instruction, change of electives, admission of students, discipline, general absences, etc.; while each professor and instructor has sole charge of his rooms, apparatus, classes, the instruction given in his department, and the admission, retention, passing, or disciplining of students in his classes. The heads of departments are made responsible to the Director and he to the Board, while the subordinates are directly responsible to the professor in charge of the department to which they belong.

EMPLOYMENT.

The question is often asked, if the Michigan Mining School can promise employment to students, on graduation. The only answer is, that neither the Mining School nor any other self-respecting institution can make any such promises. The question of employment depends on too many factors. to be promised three or four years in advance. It depends on the demand and the supply, which are liable to vary from year to year; and it also very largely depends on a student's "personal equation."

The Michigan Mining School does not seek to attract students through holding out any inducement except one, *i. e.*, that owing to its location, to its specially prepared equipment, and its distinctive purposes it can give an education that is practical and adapted to assist the student in his future work. It endeavors at least to give him more in a shorter number of years and at a less expense than he will obtain elsewhere. Its principles and methods are original, distinct and independent; based only upon its location and its object of educating persons in all branches of knowledge that relate to the development of the mineral wealth of the country—since it is the only institution in the United States distinctively devoted to that purpose. It tries to meet the spirit and needs of this day and generation.

That the Mining School has succeded in giving an education that is practically available for "bread winning" purposes, the occupations of its graduates given earlier in the catalogue is sufficient proof.

The law of supply and demand will apply to the employment of the graduates of the Mining School as it does in every other case. Prior to 1893 the demands upon the Mining School was greater than it had suitable men to supply, and so far as now known all its graduates are employed, while this year a number of its students have been engaged prior to graduation.

People are prone to forget the general laws of Political Economy, as shown in periods of prosperity, and in business depressions and panics. The student is apt to think that because at any one time there is a depression in the profession he is proposing to follow, that therefore there is no future in it; overlooking the fact that such depressions are shown by history to be incident to every occupation, and that prosperity follows stagnation as surely as the latter will succeed a period of marked business activity. The cycle may be formulated as "a state of quiescence,—next improvement,—growing confidence,—prosperity,—excitement,—over-trading,—convulsion,—pressure,—stagnation,—distress,– ending again in quiescence", when the cycle is again repeated. Thus it follows, that a pupil entering upon his preparation for his future occupation in a time of prosperity is often less sure of employment on graduation than one who starts upon this preparation during a time of distress.

The following table indicates that these periods of depression are not confined to any one country or business, political party, or tariff, but are widespread, if not universal—and are dependent upon some general periodic law belonging in common to all the commercial nations of the globe.

DATES OF COMMERCIAL CRISES.*

FRANCE.	ENGLAND.	UNITED STATES.
1804	1803	------
1810	1810	------
1813–14	1815	1814
1818	1818	1818
1825	1825	1826
1830	1830	1829–31
1836–39	1836–39	1837-39
1847	1847	1848
1857	1857	1857
1864	1864–66	1864
------	1873	1873
1882	1882	1884
1893	1890–91	1893

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* A Brief History of Panics, Juglar and Thorn, pp. 19, 22.

The periodic time is variable, but latterly it appears to be from eight to ten years in length roughly divided as follows: "Prosperity, for five to seven years; panic, a few months to a few years; and liquidation about a few years." The past three panics have been followed by strikes in 1877, 1885–86 and 1894, that greatly retarded the advancing tide of prosperity. The natural law is to prepare in dull times to take advantage of the active years, and this applies to mining as well as to all other occupations.

The success of a graduate depends very much upon himself, and it is evident from the positions occupied by the graduates, that rarely if ever has a student's capacity been misjudged when engaged in his undergraduate work.

The most forcible law deduced from the career of the Mining School graduates is the necessity of avoiding catching that dangerous and almost incurable disease, self-conceit, which renders worthless so large a proportion of mankind for employment in any capacity.

Every graduate should bear in mind that his education has simply prepared him to begin, and that in three or four years of undergraduate study, he cannot expect to master work that takes a man's life time. He should be humble and modest and above all remember that "he that humbleth himself shall be exalted" if he has patience, and is found worthy and well qualified. More than one graduate of this institution has found his progress over a rough and rugged road, and has met with numerous obstructions simply and purely on account of his unwillingness or inability to learn the above lesson, and not on account of any deficiency in training or ability.

A thorough, hard working student, with the power to command the respect of men, to manage those under him, and to work harmoniously with his fellow officers, will hardly ever fail of obtaining the choicest positions that are open to him; especially after having had the practical work and experience about the mines that the graduates of this school have.

Education and training do not give qualities to any man; they simply sharpen and develop those natural abilities that he possesses; hence, if he is not by nature fitted for a certain position, he ought not, and will not be likely, to obtain it. On the other hand, whatever may be a man's natural abilities, he will not be likely to obtain a position of any high grade unless he has been educated for it, either in school or outside—the outside education being by far the most expensive kind of education, both for him and his employers, that can be obtained.

Slothful, lazy, careless, dissipated and inefficient students will not, naturally, obtain places as readily as the hard-working ones, other things being equal; since until they reform, business men do not wish to employ them and do not trust them. They certainly will not be recommended as different from what they are by the Director of the Mining School, since a man who cannot be trusted to attend faithfully to his work when engaged in obtaining his professional training, is not one in whose hands it is safe to place important business and mining interests, for obtaining a professional training in this institution, is an entirely different affair from getting the general education given in the literary departments of colleges and universities.

Students should remember that their conduct, from the day they enter the Mining School until they leave it, has an all important bearing upon their future position and standing, and the past history of its graduates most emphatically proves it.

The Director of the Mining School makes one invariable rule, *i. e.*, that all persons desiring students or graduates of this School shall be informed of the defects, as well as of the virtues, of the candidates, so far as he knows them; believing that such a course is the only one that is just either to the employer, to the student, or to the School· When information is fully given to the Director concerning the position and desired qualities of the person to fill it, pains are taken to select the student who is believed to be the most suitable party.

In order to secure the best future for themselves, students are urged to neglect no opportunities, beyond those afforded by the School, to inform themselves in the practical work of mining.

The graduates are also urged to turn their attention to a field in which success is almost sure, to men of ability and energy; to enter the mines or works as laborers, miners, foremen, or in some other subordinate capacity, and thoroughly master every detail, from the lowest to the highest work, since only men who have had this experience are apt to obtain later the highest positions. There is a great dearth of educated men, who have had also sufficient practical experience, to place in charge of the important mineral interests of the country.

It is men who have had a thorough education, both in theoretical and practical mining, and who have worked in every grade and position, that are sought to take charge of our mines and their allied industries. The future is for the man who is modest and willing to commence at the bottom of his profession, and who is conscious of the truth, that on graduation he is only just prepared to begin his work.

The graduates of the school are urged to keep the Director constantly informed concerning their positions, salaries, etc., and also what their desires are, in order that they may be assisted to advance, if opportunity offers.

While the Director may not be able to serve them, yet whenever the time comes that he can assist them he must have the information at hand, since when men are wanted, they are desired without delay. Failure to keep the Director properly informed has cost many a graduate the loss of important positions—*e. g.*, one a young graduate lost a position paying $2,000 a year to start on, simply because he had neglected to give his new address, and the letters and telegrams sent could not be delivered. The Director personally considers it his duty to aid every graduate when he can, the only question being the fitness of that graduate for the position. The Director has no time to pay attention to or to remember the past piques and prejudices of the graduate, whom he may have had to discipline when a student —he has only time to consider the commercial aspect of the case—is the graduate in question the man for the place? The character and ability of the man and not any personal likes or dislikes are the points to which the Director has and always must pay his attention.

Officers of mines, and others, desiring surveyors, engineers, draughtsmen, foremen, chemists, assayers, etc., are requested to make their wants fully known to the Director of the Mining School, who will then recommend suitable candidates to them, if he knows of any.

The inquiry is frequently made by persons intending to become students, if they can attend to their school work and earn enough to pay their way at the same time. Such a course is not practicable, as the regular school work, if it is done as it should be, requires the entire available time of any student, however strong and able he may be. As a special student, taking only a few studies, one might be able to procure work to pay his way. The location of the school in a village, however, offers but little of the irregular work that a student wishes to obtain. The better way for the needy student is either to attend to his school and to his labor in alternate years, or else to borrow the means to continue his education, repaying through his increased earning power after graduation.

The Mining School itself has more or less assistantships, that are open from year to year, which properly qualified undergraduate or graduate students can avail themselves of if they wish.

Likewise it is preferred to employ the graduates of this School, in preference to those of other institutions, in the various instructorships, since a man trained in the methods employed in any school, is more useful in subordinate positions in that school at first, than is one ignorant of the special duties required. This does not apply to professorships since continued "inbreeding" is disastrous to any educational institution.

The salaries obtained upon graduation have been from about $500 to $1,800, averaging about $900 per year. The lower salaries were obtained by students who had less practical experience with men and with the world in general; these were obliged to spend some time in acquiring a special kind of knowledge that the Mining School cannot give.

So far as known, the salaries have increased, after a varied time from $900 to even $6,000 or more per year. All this, however, is dependent upon the demand and supply, the state of the mining industries at any time, and upon other factors too numerous to be mentioned.

LOCATION AND ROUTES.

The State of Michigan is divided by the three great lakes and the straits of Mackinaw into two peninsulas, both of which form valuable portions of the State, and are especially distinguished for their productions.

The Lower Peninsula has great prominence from its fruit, grain and other agricultural products, its lumber, salt, gypsum, coal, building stones, etc.

The Upper Peninsula is noted for its production of copper, iron ore, building stones, and lumber, while its agricultural interests are rapidly increasing.

The Lower Peninsula is some 282 miles in extreme length and 198 miles in width, while the Upper Peninsula is some 347 miles in length and 165 miles in width, or much larger than the state of Massachusetts, while its climate is much like that of Maine.

The chief mining districts in the Upper Peninsula are known as the Marquette, Menominee and Gogebic Iron Ranges, and the Copper District.

This latter has three distinct divisions, respectively known as the Keweenaw, Portage Lake and Ontonagon Districts.

The chief cities and towns of the Upper Peninsula are Baraga, Bessemer, Calumet, Champion, Crystal Falls, Escanaba, Gladstone, Hancock, Houghton, Iron Mountain, Iron River, Ironwood, Ishpeming, L'Anse, Lake Linden, Laurium, Manistique, Menominee, Munising, Negaunee, Newberry, Norway, Ontonagon, Red Jacket, Republic, St. Ignace, Sault Ste. Marie and Wakefield.

The Michigan Mining School is located in the village of Houghton (Portage township). The twin villages of Houghton and Hancock lie in the sheltered valley of Portage Lake, an arm of Lake Superior. The climate is dry, bracing and healthful. Although Houghton is in a high latitude, yet one is far less inconvenienced by the cold here than he is much further south along the Atlantic coast, or in the immediate vicinity of the great lakes; and can generally wear lighter clothing in the winter. This is due to the dryness of the Houghton climate, a climate which is free from malaria, hay fever, etc. In general students coming from localities further south, even from Alabama, Mississippi, Texas and Mexico, have found health and strength improved by the change. The town has an abundant supply of excellent and pure spring water.

Houghton is easily reached by rail from Detroit, Chicago, Milwaukee, St. Paul, Superior and Duluth; and by steamer from all the important ports on the chain of the great lakes. Within the State half fare rates are given given to the students of the Mining School by the Duluth, South Shore & Atlantic Railway and its associated railroads. Application for a permit allowing the student to purchase half fare tickets is to be made to the Director a week or more before the student has occasion for its first use. The permit once obtained is good during that calendar year, if the party remains a student in the school.

Intending students frequently inquire concerning the routes they can take to reach the Mining School from various localities, and special information is here given:

By rail Houghton is distant from Ann Arbor 582 miles, Bessemer 144 miles, Calumet 14 miles, Champion 64 miles, Chicago 402 miles, Crystal Falls, 147 miles, Detroit 545 miles, Duluth 279 miles, Escanaba 145 miles, Hancock 1 mile, Iron Mountain 119 miles, Ironwood 150 miles, Ishpeming 80 miles, Lake Linden 10 miles, Lansing 513 miles, Laurium 14 miles, Manistique 231 miles, Marquette 95 miles, Menominee 209 miles, Milwaukee 327 miles, Negaunee 83 miles, Newberry 191 miles, Ontonagon 118 miles, Red Jacket 15 miles, Republic 73 miles, St. Ignace 246 miles, Sault Ste. Marie 250 miles, and Ypsilanti 575 miles.

From Detroit one travels by the Michigan Central Railway to Mackinaw City, via Bay City. At Mackinaw City the cars of the Duluth, South Shore & Atlantic Railway are taken direct to Houghton. Time from Detroit about twenty-one hours. From Sault Ste. Marie, the Duluth, South Shore & Atlantic Railway carries its passengers direct to Houghton, time about thirteen hours. The same railway is taken from Duluth and Superior to reach the Mining School. Passengers from Chicago and Milwaukee take either the Chicago, Milwaukee & St. Paul Railway, via Champion; or the Chicago & Northwestern Railway, via Negaunee and Ishpeming; at which places, on both routes, the passengers transfer to the Duluth, South Shore & Atlantic Railway for Houghton. Timè from Chicago to Houghton, about fifteen hours.

Students desiring to reach Houghton by boat, can take the steamers of the Lake Michigan and Lake Superior Transportation Company, at Chicago or Milwaukee, taking about three days from Chicago. From Buffalo, Cleveland and Detroit, one can take the steamers of The Western Transit Company, The Erie and Western Transportation Company, and others. Time from Buffalo about five days, Cleveland four days, and Detroit three days.

Any of these lines can be taken from Duluth.

Special information, descriptive pamphlets, time tables and rates can be obtained from the General Passenger Agents of the various companies by writing to their respective offices, as follows:

Duluth, South Shore & Atlantic Railway Co., Marquette, Michigan.

Michigan Central Railway Co., Chicago, Ill., or Detroit, Mich.

Chicago, Milwaukee & St. Paul Railway Co., Chicago, Ill.

Chicago & Northwestern Railway Co., Chicago, Ill.

The Lake Michigan & Lake Superior Transportation Co., Rush and North Water Streets, Chicago, Ill.

The Western Transit Co , No. 47 Main Street, Buffalo, N. Y.

The Erie & Western Transportation Co., Atlantic Dock, Buffalo, N. Y.

Houghton County is the third wealthiest county in Michigan, being surpassed only by Wayne (Detroit) and Kent (Grand Rapids) Counties; and has an assessed valuation of $40,000,000. The population of the county, with its various townships and villages, is here given according to the State census of 1894.

	1890.	1894.
Adams Township,		1,675
Calumet "	12,529	16,709
Chassell "	680	993
Duncan "	680	984
Franklin "	2,687	2,685
Hancock "	2,737	4,345
Laird "	159	231
Osceola "	3,630	4,712
Portage "	3,531	3,417
Quincy "	1,490	1,490
Schoolcraft "	3,325	3,908
Torch Lake "	2,904	3,055
Total	35,389	45,398

Increase in 3 years	10,009
Increase in 14 years	22,925
Increase in 40 years	44,681

The population of the villages is as follows:

	1894.
Atlantic Mine	1,675
Calumet	2,192
Chassell	554
Crystal Lake	55
Gregoryville	320
Hancock	1,662
Houghton	2,178
Kenton	113
Kitchie	75
Lake Linden	2,443
Mills' Station	794
Osceola	1,514
Oskar	171
Perkinsville	520
Quincy Mill	151
Quincy Mine	1,490
Red Jacket	3,242
Sidnaw	344
Tamarack and North Tamarack	1,402
Withey	184

Within a radius of three miles some 8,000 inhabitants are located about Houghton.

The village of Houghton is the county seat, has many wealthy citizens, excellent society, and is the residence town of the county; while that portion in which the Mining School is situated is the equal in beauty to any New England town.

The accompanying map will give a fair idea to the prospective student of the location of the Mining School and the adjacent mines.

While the School itself is situated in the Portage Lake copper district, the access to the Keweenawan copper district on the north is easy; and there lie within comparatively short distances the Ontonagon copper district, and the iron mining ranges of Marquette, Menominee and Gogebic.

In the immediate vicinity of the Mining School are located the Quincy, Atlantic, Franklin and Huron copper mines; while within a radius of eleven miles are situated the Calumet and Hecla, Tamarack, Osceola and other copper mines, with their machine shops, smelting works, rolling and stamp mills, etc. In the iron mining regions lie numerous great mines, prominent among which are the Cleveland, Jackson, Lake Superior, Lake Angeline, Champion, Republic, Chapin, Vulcan, Cyclops, Colby and Norrie.

The Michigan Mining School has been located in the Upper Peninsula of Michigan for the same reason that a medical school should be in the vicinity of large hospitals, in order that it shall be associated with the objects about which it treats.

From this location the student of the Michigan Mining School is placed in a mining atmosphere, in which all his surroundings and associations are in conformity with his present and future work. He is thus enabled to see in actual operation some of the most successful and extensive mining operations now conducted anywhere.

MINERAL INDUSTRIES.

In order that some idea can be intelligently given concerning the location of the Michigan Mining School there are here collected some statistics concerning the country at large and that of Michigan in particular.

Owing to the Lake Superior basin being a unit in its mineral wealth and geological structure, it becomes very difficult to obtain statistics, that shall be separated by the state boundaries, so, in part, the productions of Northern Michigan, Wisconsin and Minnesota have to be considered together.

This causes the prolongation of the Gogebic range into Wisconsin to naturally fall with its component part in Michigan; and like manner the Vermilion and Mesabi ranges belong to the Lake Superior district and shipments.

There will first be given some general statistics regarding the mineral productions of the United States followed by a more specific description of the mining industries in the Upper Peninsula.

This material is gathered in part from the publications of the United States Census and Geological Survey reports, part from the Director's past publications, including the last catalogue of this institution, but chiefly from manuscript kindly provided by Hon. George A. Newett, the present able Commissioner of Mineral Statistics for Michigan, or taken from his very valuable report for 1895.

TOTAL MINERAL PRODUCTION. UNITED STATES.

1880	$350,319,000
1881	386,175,552
1882	435,895,259
1883	434,241,073
1884	395,489,105
1885	409,398,680

1886	445,786,594
1888	540,829,436
1889	*550,827,866
1890	619,506,161
1891	622,988,969
1892	648,616,954
1893	574,201,807
1894	527,655,562

MINERAL PRODUCTION OF MICHIGAN.

1889	$70,880,534

The States nearest are

Pennsylvania, 1889	$150,876,649
Colorado, 1889	41,126,610
Montana, 1889	33,737,775
Ohio, 1889	26,653,439

WORLD'S PRODUCTION OF IRON ORE, 1892.

United States	16,300,000 tons.
Germany and Luxemburg	11,400,000 tons.
Great Britain	11,350,000 tons.
Spain	5,350,000 tons.
France	3,650,000 tons.
Austro-Hungary	2,000,000 tons.
Russian Empire	1,500,000 tons.
Chinese Empire	1,500,000 tons.
Sweden	1,200,000 tons.
Other Countries	2,800,000 tons.
Total	57,050,000 tons.

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* U. S. census gives $587,230,662.

PRODUCTION OF IRON ORE—UNITED STATES.

YEAR.	1880.	1889.	1890.	1891.	1892.	1893.	1894.
Lake Superior District—Tons	1,677,814	7,519,614	8,944,031	7,621,465	9,564,388	6,594,618	7,692,548
All Other Mines in United States—Tons.	5,442,548	6,998,427	7,092,012	6,969,713	6,732,278	4,993,011	4,187,131
Total Product of United States—Tons	7,120,362	14,518,041	16,036,043	14,591,178	16,296,666	11,587,629	11,879,679
Value of Product, Michigan	....	$15,800,521	....	....	$16,587,521	$8,611,192	$5,844,995
Value of Product, Minnesota	....	$2,478,041	....	....	$3,090,942	$2,321,204	$2,165,802
Value of Product, Wisconsin	....	$1,840,908	....	....	$1,428,921	$584,094	$320,518
Value of Product, Pennsylvania	....	$3,063,534	....	....	$2,197,028	$1,874,313	$643,459
Value of Product, New York	....	$3,100,216	....	....	$2,379,267	$1,222,934	$396,456
Value of Product, New Jersey	....	$1,341,543	....	....	$1,388,875	$909,458	$568,056
Value of Product, Both Virginias	....	$935,290	....	....	$1,428,801	$1,050,977	$873,305
Value of Product, Alabama	....	$1,511,611	....	....	$2,422,575	$1,490,259	$1,240,895
Value of Product of United States	....	$33,351,978	....	....	$33,204,896	$19,265,973	$13,571,325

RELATIVE RANK OF THE EIGHT IRON ORE PRODUCING STATES.

No.	1850.	1860.	1870.	1880.	1889.	1893.
1	Pennsylvania.	Pennsylvania.	Pennsylvania.	Pennsylvania.	Michigan.	Michigan.
2	Ohio.	Ohio.	Michigan.	Michigan.	Alabama.	Alabama.
3	Maryland.	New York.	Ohio.	New York.	Pennsylvania.	Minnesota.
4	Tennessee.	New Jersey.	New York.	New Jersey.	New York.	Pennsylvania.
5	Kentucky.	Michigan.	Maryland.	Ohio.	Minnesota.	Virginia.
6	Virginia.	Kentucky.	Kentucky.	Missouri.	Wisconsin.	New York.
7	New Jersey.	Maryland.	Missouri.	Alabama.	Virginia.	Wisconsin.
8	New York.	Tennesse.	New Jersey.	Virginia.	Tennessee.	Tennessee.

IRON ORE SHIPMENTS, LAKE SUPERIOR DISTRICT.

Range.	1895.	Total to 1896.
Marquette Range (Michigan)	2,095,166 tons.	43,937,510 tons.
Menominee Range (Michigan)	1,694,804 tons.	18,578,827 tons.
Menominee Range (Wisconsin)	231,399 tons.	2,728,377 tons.
Gogebic Range (Michigan)	2,132,397 tons.	16,342,961 tons.
Gogebic Range (Wisconsin)	428,368 tons.	2,674,207 tons.
Mesabi Range (Minnesota)	2,778,296 tons.	5,192,504 tons.
Vermilion Range (Minnesota)	1,077,838 tons.	8,132,145 tons.
Total	10,438,268 tons.	97,586,531 tons.

GOLD MINING.

Production.	California,	1889,	$12,586,722 00
"	Colorado,	"	3,883,859 00

SILVER MINING.

Production,	Colorado,	1889,	Coining Value	$23,757,751 00
"	Montana,	"	"	17,468,960 00
"	Utah,	"	"	9,057,014 00

GOLD AND SILVER (COMBINED) MINING.

Expenditures,	Colorado,	1889,	$13,834,332 00
"	California,	"	12,506,555 00
"	Montana,	"	9,259,657 00
"	Nevada,	"	8,254,755 00
Wages,	Colorado,	1889,	9,339,875 00
"	California,	"	9,191,500 00
"	Montana,	"	5,881,500 00
"	Nevada,	"	3,522,280 00

Total Horse Power of all Engines in 1889 employed in Gold and Silver Mining, United States, 55,122.

COPPER MINING.

Expenditures,	Michigan,	1889,	$7,478,828 00
"	Montana,	"	3,204,455 00
Wages,	Michigan,	1889,	3,174,363 00
"	Montana,	"	2,010,940 00

HORSE POWER OF ENGINES, COPPER MINING.

Michigan,	1889	29,545 horse power.
Montana,	"	3,530 horse power.

In 1896 the Calumet and Hecla Co. and the Tamarack and Osceola Co. alone have 60,000 horse power: Calumet and Hecla Co., 40,000, Tamarack and Osceola Co., 20,000.

CAPITAL INVESTED, COPPER MINING.

Michigan,	1889	$33,111.253 00
Montana,	"	23,395,000 00

LARGEST AMOUNTS OF DIVIDENDS PAID BY MINES ACTIVE AT PRESENT TIME.

Calumet and Hecla, Michigan	$44,850,000 00
Belcher (Silver-Gold), Nevada	15,397,800 00
Ontario (Silver-Lead), Utah	13,175,000 00
Granite Mountain (Silver), Montana	12,120,000 00
Quincy (Copper), Michigan	7,620,000 00

Total dividends paid by the copper mines of Michigan, $68,460,375.

POUNDS OF COPPER PRODUCED IN VARIOUS STATES AND IN THE UNITED STATES.

Year.	Michigan.	Montana.	Colorado.	Arizona.	Utah.	California.	United States.
1883	59,702,404	24,664,346	1,152,652	23,874,963	341,835	1,600,862	115,526,053
1884	69,353,202	43,093,054	2,013,125	26,734,345	265,526	876,166	144,946,653
1885	72,147,889	67,797,864	1,146,460	22,706,366	126,199	469,028	165,875,483
1886	80,918,460	57,611,621	409,306	15,657,035	500,000	430,210	157,763,043
1887	76,028,697	78,699,677	2,012,027	17.720,462	2,500,000	1,600,000	181,477,331
1888	86,472,034	97,897,968	1,621,100	31,797,300	2,131,047	1,570,021	226,361,466
1889	88,175,675	98,222,444	1,170,053	31,586,185	65,467	151,505	226,775,962
1890	101,410.277	112,980,896	3,585,691	34,796,689	1,036,636	23,347	259,763,092
1891	114,222,709	112,063,320	6,336,878	39,873,279	1,562,098	3,397,405	284,121,764
1892	123,198,460	163,206,128	7,593,647	38,436.099	2,209,428	2,980,944	344,998,679
1893	112,605,078	155,209,133	7,695,826	43,902,824	1,135,330	239,682	329,354,398
1894	114,308,870	183,072,156	6,481,413	44,514,894	1,147,570	120,000	354,188,374
1895	129,573,856	185,000,000	....	48,000,000	....	....	385,573,856

COPPER DISTRICT.

PORTAGE LAKE DIVISION.

This division is the principal copper producing district of Michigan, and its territory is embraced in the map which is given in this catalogue and shows the location of the Michigan Mining School in its midst.

Calumet and Hecla Mine.

This famous mine has as its lode an old sea beach conglomerate which is underlaid by a lava flow, as well as overlaid by one; and the copper has been chemically deposited within this conglomerate by the percolating waters long subsequent to its formation, and after it was deeply buried under successive lava flows. Although many speak of the Calumet vein, neither that mine nor any other in the Portage Lake division is worked upon a vein or on anything that in the slightest degree approaches a vein in its character. All are bed mines—part conglomerate beds, part lava flows forming beds. The bed of the Calumet lode is inclined at an angle of about 39 degrees to the northwest, and averages about 16 feet in width.

From 6 to 30 pounds of copper are obtained from a ton of the sea beach rock, averaging about 9 pounds to the ton.

This mine has the largest machinery and the deepest shafts of any mine in the world.*

Beginning on the shore of Lake Superior, there are the Lake Superior Water Works, Pump House, and Boiler House, containing one Worthington high pressure compound condensing pump with cylinders of 19 1-4 inches and 33 3-8 by 24 inches, and plungers 9 by 24 inches.

Two spare Worthington pumps with cylinders 10 by 18 inches, and two boilers 64 inches diameter by 17 feet long, of 300 horse power,

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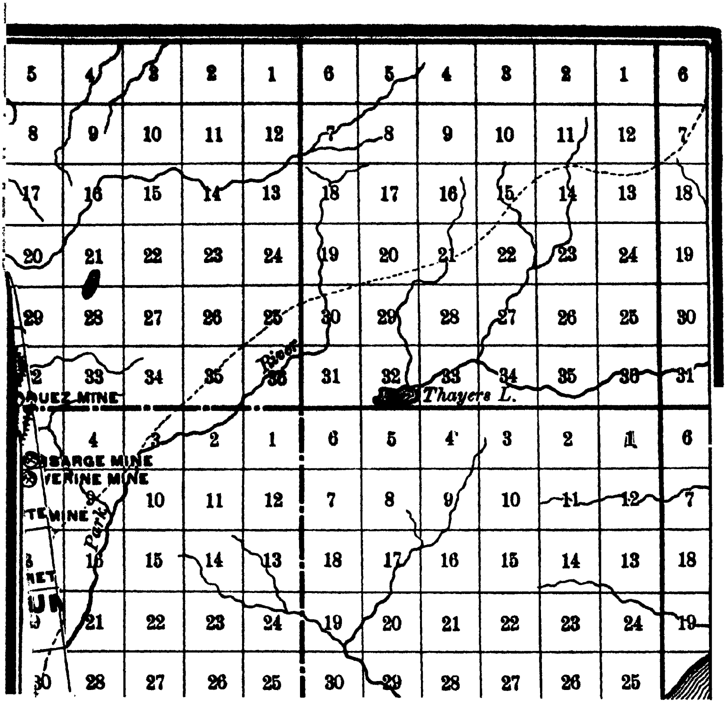
*The following is mainly condensed from President Agassiz's Report for 1893, with some later additions.



UEZ MINE
BARGE MINE
VERINE MINE
TE MINE
NET
UN
Park River
Thayers L.

and one locomotive boiler 54 inches diameter, of 100 horse power. When fully equipped, the capacity of these works will be 2,000,000 gallons a day. The water is taken from a pipe 18 inches in diameter, and extending 1,200 feet into Lake Superior. It is pumped through a 12-inch wrought-iron pipe line 4½ miles in length, to an altitude of more than 700 feet, to the mine, where it is distributed over the whole location. A new water tower that will contain 520,000 gallons is in the course of construction.

The real estate of the Company consists of 2,599 25-100 acres of mineral land in Houghton county, and 20,352 35-100 acres of timber lands in Keweenaw, Houghton and Ontonagon counties. At the Stamp Mill there are 988 19-100 acres.

There are 698 houses belonging to the Company, of which 570 are on the mine location, 106 at the lake, and 22 at the Smelting Works. On leased lots the men own 782 houses at the mine, and 159 at the lake, while the Company employs some 3,456 men.

There are 20 churches on the property of the company, the greater number of which have been materially assisted by the Company at some time in their history.

There are, on land of the Company, six schools at the mine and lake, built partly at the cost of the Company and partly by the school district. The Company also owns a hotel.

There are at the mine, for cutting sets of timber used underground, a timber building, a large machine shop 225 by 250 feet, with a full complement of tools. Also at the mine three blacksmith's shops, two warehouses, two carpenter shops, and a paint shop.

The Calumet Engine House is a building of brick and stone, 146 by 62 feet. It contains: The compound engine "Superior," with cylinders of 40 inches, and 70 by 72 inch stroke of 4,700 horse power; the Corliss engine "Rockland," used as a spare, of 600 horse power; the Leavitt engine "Baraga," 40 by 60 inches, also a spare, of 2,000 horse power; one pair 32 by 48 inch Rand Compressors, with a capacity of 26 air drills; and one pair 36 by 60 inch Rand Compressors, with a capacity of 41 air drills. There are four drums 20 feet 6¼ inches in diameter by 8 feet 4 inches face, to hoist from a depth of 4,000 feet from shafts Nos. 2, 4 and 5 Calumet, and No. 3 Hecla. By winding over and not increasing the load a depth of 6,000 feet may be reached.

The Boiler House is of stone 77 by 60 feet. It contains five boilers, two of 84 inches in diameter by 35 feet long, made by Kendall and Roberts; three of 90 inches diameter by 34 feet 6 5-8 inches long, made by the Dickson Manufacturing Company, the Southwark Foundry, and the I. P. Morris Company; total horse power, 2,780. The stack is 5 feet 6 inches internal diameter, and 150 feet high.

The Hecla Engine House is a brick building 80 by 47 feet, with an ell 44 by 17 feet 5 inches, and contains the compound engine "Frontenac," 27 3-4 and 48 by 72 inches, of 2,000 horse power: the Corliss engine "La Salle," 30 by 72 inches, used as a spare, of 900 horse power; and the Corliss engine "Perrot," 30 by 48 inches, also a spare engine, of 600 horse power; in addition, the two pair of compressors, water plunger type, 42 by 60 inches, with a capacity of 144 air drills, 72 drills for each set; one pair of Rand Compressors, 28 by 48 inches, of a capacity of 31 air drills.

The Boiler House is of brick, 80 by 58 feet, and contains three boilers made by Kendall and Roberts, 84 inches by 32 feet 10 3-4 inches, and two boilers made by the Dickson Manufacturing Co., 90 inches by 34 feet 4 inches, with a total of 1,690 horse power. The brick stack is 4 feet 6 inches inside diameter and 120 feet high.

On the Hecla, another Hoisting Engine and Boiler House contains the triple expansion hoisting engines "Gratiot," "Houghton," and "Seneca," of 2,000 horse power each, having cylinders 18 and 27 3-4 inches, and 48 by 90 inches, fitted with conical hoisting drums to reach a depth of 5,500 feet. The engine house is of stone, 112 by 78 feet. The boiler house of the same material, is 76 by 68 feet. There are five boilers, of 505 horse power each, 90 inches in diameter by 34 feet 6 inches long, built by the Dickson Manufacturing Company of Scranton, Penn., and the I. P. Morris Co., of Philadelphia, Penn. The brick stack is 9 feet 4 inches inside diameter, and 200 feet high.

The Engine House for Hecla shafts Nos. 7 and 8 contains the triple-expansion engines "Hancock" and "Pewabic," each of 2,000 horse-power; each operating by spur gearing its own drum, which is 25 feet in diameter by 8 feet 2 7-8 inches face, having a rope capacity of 5,500 feet, of 1 3-8 inch diameter. The cylinders are 20 1-8 and 31 3-4 inches and 50 by 48 inches. The maximum speed is 92 revolutions per minute, which is 3 3-4 revolutions to one of the drums. The house is 122 feet long, and 50 feet wide; it is built of stone.

The Boiler House will eventually hold ten boilers; it now contain three. They are 90 inches in diameter by 34 feet 6 inches long, and 505 horse power each. The house is 150 feet long and 65 feet wide. The stack is 12 feet 6 inches inside diameter, and 250 feet high.

Shafts Nos. 9 and 10 Hecla, are operated from a Hoisting Engine House built of stone, 75 by 46 feet. It contains two compound hoisting engines, the "Detroit" and "Onota," of 1,000 horse power combined, having cylinders 18 and 32 by 48 inches stroke, built by George H. Corliss. These engines drive by spur gearing two hoisting drums, formerly located at the Superior Engine House, each 20 feet in diameter by 8 feet 4 inches face, and will wind 4,000 feet of 1¼ inch rope. The drums make one revolution for every three revolutions of the engine.

In the Hoisting Engine House operating shafts Nos. 11 and 12 Hecla, there is a pair of Woodruff and Beach engines built in 1869, of 20 inches diameter by 48 inches stroke, with two drums of 8 feet diameter and 6 feet face. As one of the man-shaft engines, is used a vertical engine 26 inches in diameter by 36 inch stroke, built in 1867.

The company has eight new shaft-rock houses, extending from Calumet No. 5 to Hecla No. 12, a total length on the surface of 9,000 feet; the copper shute having in all a length of something over two miles underground, say 10,630 feet. There are eight shaft-rock houses at Hecla and at Calumet shafts, each containing a Westinghouse driving engine of 60 horse power, and two "Blake" crushers; each rock house with a bin capacity of about 1,500 tons. Both at No. 5 Calumet and at No. 4 Hecla, there is a fan for underground ventilation: these are 30 feet in diameter, with a capacity of about 100,000 cubic feet per minute. There are man-hoist buildings at five of the Hecla and three of the Calumet shafts; each contains a pair of engines and drum, used only for taking men up and down. Twenty-eight men can ride on one of the cars; they are especially constructed for that use. Three of the houses contain each a pair of 20 by 30 inch engines, with drums to wind 4,000 feet of 1¼ inch rope; the other five houses, one pair of engines 20 by 36 inches, with drums to wind 6,000 feet of 1¼ inch rope.

The Electric Light and Power House is built of stone, 74 by 74 feet; it contains a Porter-Allen engine, 18 inches in diameter by 36 inch stroke, of 400 horse power. A Westinghouse compound engine 23 and 40 by 20 inches, and 740 horse power, will be installed in this house.

There are two electric light dynamos for 1,000 sixteen candle power lights each; three Brush arc-light dynamos for 74 lights; five Brush generators 120 horse power each, with electric lines leading to the principal buildings, and to the three underground electric pumps at the Hecla end. Each pump has three double acting plungers 5⅜ inches in diameter by 18 inch stroke, to run 50 revolutions per minute. At the Calumet end in No. 4 shaft, there are to be five electric pumps, each with three double acting plungers 5⅜ inches in diameter by 18 inch stroke, to run 50 revolutions per minute. These pumps are placed 800 feet apart, having a vertical lift of 600 feet: the pump column is 8 inches in diameter. The company has at Calumet Nos. 4 and 5 shafts two spare steam Worthington pumps, with cylinders 10 and 18 inches by 18 inches, of a capacity of over 500,000 gallons per 24 hours.

The six-compartment Whiting Shaft has reached a depth of 4,900 feet. It intersected the Calumet lode at a depth of 3,300 feet, and will reach the bottom of the Company's territory at a depth of 5,000 feet.

It is equipped with a sinking-engine house of stone, 69 by 36 feet, containing a pair of horizontal tandem Corliss engines, with cylinders 16 and 32 inches in diameter by 48 inch stroke, with tail-rope house, and has the Whiting drum system.

The main hoisting-engine house, built of stone, 220 by 70 feet, contains two pair of triple expansion engines, of 3000 horse power per pair, having cylinders 20⅛ by 31¾, and 50 inches in diameter by 72 inch stroke, to run 60 revolutions per minute, and fitted with the Whiting drum system, arranged to hoist ten tons per load, at a speed of 60 feet per second. The tail house for the fleet gear is 412 by 32 feet, and is placed on the north end of the engine house. The sheave house is placed at the south end; it is 43 by 32 feet. These engines are calculated to hoist from a maximum vertical depth of 5000 feet.

The Boiler House is built of stone, 150 by 68 feet and will contain ten boilers, each 90 inches in diameter by 34 feet 6 inches long. and adopted to a working pressure of 185 pounds, at which they will each furnish steam for 1,000 horse power. There are at present six boilers in the house. The stack is of brick, 12½ feet inside diameter and 250 feet high.

The water used by the condensing engine is supplied from the Calumet Pond Water Works, where the Company has a main pond of a capacity of 60,000,000 gallons at five feet depth, and an auxiliary pond of a capacity of 30,000,000 gallons, at 2½ feet; both ponds are, when filled, of a capacity of say 100,000,000 gallons.

The Water Works Building consists of an engine and boiler house of brick, 100 by 45 feet; it contains a Leavitt pumping engine of a capacity of 5,000,000 gallons per day, steam cylinders 11¾ inches, and plungers 17 by 24 inches. In addition, there are two Worthington pumping-engines, of a capacity of 14,000,000 gallons per day; one pump with steam cylinders 14 and 24 by 36 inches, and 20 by 36 inch plungers, of a capacity of 4,000,000 gallons; and two others with steam cylinders 21 and 42 by 36 inches, and 29 by 36 inch plungers, of a capacity of 10,000,000 gallons. The boiler house contains three boilers, Kendall & Roberts make, of 603 horse power, two of 54 inches by 26 feet 10 inches; and one of 84 inches by 35 feet. A pipe-line 16 and 24 inches in diameter, runs to the Superior Engine House, and from there north and south along the line of the lode.

The length of all the shafts sunk below the average level of the stopes is over two miles, and the length of all the drifts run below the average level of the stopes is 13 6-10 miles.

At Lake Linden are located the Stamp Mills, the Calumet Mill containing eleven Leavitt heads with steam cylinders of 14 and 21½ by 24 inches stroke, with a complete equipment of washers, Huntington and Haberle grinding mills, and slime tables.

As spare power, the Company has a Westinghouse driving-engine of 200 horse power. At the Hecla Stamp Mill an addition has been made of four heads, which gives eleven Leavitt heads, with steam cylinders 14 and 21½ by 24 inch stroke, and an equipment similar to that of the Calumet mill. The Company is placing solid anvils under all the stamps.

The Stamp Mills and Water Works Boiler House contains eleven boilers, four of 80 inches diameter by 32 feet long, and seven of 90 inches diameter by 34 four feet 6 inches long, made by Kendall & Roberts, the Dickson Manufacturing Company, the Southwark Foundry, and the I. P. Morris Co., aggregating 4,730 horse power, commercial standard. In 1895 an addition of 160x70 feet has been made to the boiler house, and two brick stacks erected, one 14 feet diameter by 250 feet high and the other 12 feet diameter by 185 feet high.

Torch Lake Water Works, which supply the Stamp Mills, consist of the triple-expansion pumping engine "Michigan," of a capacity of 60,000,000 gallons daily, with the following engines as spare pumps: The compound pumping engine "Erie," with a capacity of 10,000,000 gallons daily; the compound pumping engine "Ontario," with a capacity of 20,000,000 gallons daily; the geared pumping engine "Huron," with a capacity of 20,000,000 gallons daily.

The compound driving engine "Wabeek," 22¾ and 38 by 60 inch stroke, of 728 horse power, operates the washing machinery, the stamp steam-valve gear, and the sand wheels, by means of wire rope transmission. The stamped sand is distributed by four sand wheels; the Calumet 40-foot sand wheel, with a capacity of 18,000,000 gallons, and of 1,600 tons of sand; the Calumet 50-foot sand wheel, with a capacity of 30,000,000 gallons and of 3,000 tons of sand. As a spare engine for the Calumet wheel, the Company has a high-pressure engine 24 by 48 inch stroke, of 250 horse power. The Hecla 40- and 50-foot sand wheels have the same capacity as the Calumet sand wheels of the same dimensions. The spare engine for the Hecla wheels is a duplicate of the Calumet.

A new stone building in which an electric plant has recently been installed has been completed. There are three arc dynamos, Brush, each having a capacity of thirty 2,000 candle-power lights, and two Thompson Houston dynamos, incandescent, of similar power. These are driven by a Lake Erie Engine Works triple-expansion engine 7¼, 12 and 19-inch. In this same building is an artesian well 15 inches in diameter by 1,500 feet deep, which has recently been finished, making two at the mills. This provides water for the boilers. An air pipe is sent down the well to a distance of 200 feet, a little artificial assistance being necessary to send the water to surface. A tank located on the hill just back of the mill holds one million gallons of water, and gives a pressure at the mill of 150 lbs. per square inch. From these two wells 500,000 gallons of water are drawn daily.

The horse power of the boilers at the mine, commercial standard, is 13,765; the horse power of the boilers at the Lake Superior Water Works is 400; the horse power of the boilers at the Stamp Mills is 6,235; the horse power of the boilers now building is 2,022; and the total horse power, commercial standard, is 22,422. The aggregate horse power which can be developed by the engines belonging to the Company is 40,000.

The Smelting Works at Torch Lake occupy nearly thirty acres; they are connected with the Stamp Mills by a short line of railway, over which the mineral trains handle the daily product, which is there stored in the mineral houses.

The plant consists of four stone furnace buildings 80 by 130 feet each, with four furnaces, boshes, cranes, and all the ordinary equipment; one blister furnace building, of stone, 50 by 70 feet, with two furnaces; one cupola building containing two furnaces, with the necessary engines, blowers and boilers; machinists' and blacksmiths' outfits, electric light plant, etc. Mineral building No. 1 has a bin capacity of 2,000 tons, and mineral building No. 2 and its addition has a capacity of about 9,000 tons; and there are two wharves of a length of over 1,000 feet, with the necessary hoisting apparatus for coal and limestone.

Tamarack Mine.[*]

This is second only to the Calumet and Hecla, in the extent of its operations, and takes a second place to none other in the enterprise and skill displayed in the conducting of its mining and milling affairs. The company owns 29 forties in sections 10, 11, 12, and 15, these all being favored with the Calumet conglomerate lode, It is upon the latter that operations have thus far been principally confined by the company working upon an extension of the dip of the lode from a point where it leaves the western boundary of the Calumet and Hecla's property.

No. 1 shaft is located at the southeast corner of the company's property, and close to the south and west line of the Calumet and Hecla's lands, the latter surrounding this forty on three sides.

Like all the shafts of the company, No. 1 is vertical. It is to the 18th level, 3,234 feet from the surface.

No. 2 shaft is about 600 feet north of No. 1 and is to the 22d level, having been sunk from the 19th in 1895. The crosscut connecting with the lode is now just about completed, February 18, 1896. The lode having an inclination to the northwest of about 38 degrees, and the shaft being vertical, each added level finds the crosscuts connecting shaft and lode growing longer, so that at the 22d the distance is about 1,300 feet. Nos. 1 and 2 are 3-compartment shafts, two cageways and a timber way.

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[*] The following is largely condensed and rearranged from Mr. Geo. A. Newett's report and manuscript.

No. 3 is north of No. 2 something like 4,200 feet, being located on section 11, and struck the lode on August 5, 1894, at a depth from surface of 4,185 feet.

The lode is very wide, something like 22 feet, nearly twice as thick as the conglomerate generally is.

No. 4 shaft is located about 700 feet north of No 3, reached the lode January 9, 1895, at a depth of 4,393 feet.

No. 5 shaft, the new one, has been located 3,300 feet south of No. 4. The work of clearing the ground, preparatory to beginning the sinking, was commenced on the 11th of August, 1895.

The company has erected a substantial shaft house, an engine and compressor house, and has installed hoisting and compressing machinery.

The shaft's dimensions are 27 ft. 5 in. x 7 ft. 2 in., and will contain five compartments, four cage-ways and a ladder and pipe way. It is expected it will strike the lode at a depth of about 4,600 feet.

In the sinking of the deep shafts Nos. 3 and 4, not a man was injured, which is a remarkable record considering that about 9,000 feet of sinking was done. It is the desire to sink No. 5 shaft at the rate of 100 feet per month.

At No. 3 shaft there are horizontal duplex engines, 34x48 inches, connected to a conical drum 12 feet at smallest diameter, 36 feet at largest, having a possible wind of 7,000 feet of rope. At places in the shaft the cages attain a maximum speed of 4,000 feet per minute. The cages at the different shafts are worked in balance. There is a fine new shaft and rock house at No. 3 that is conveniently arranged. There are breakers 18x24 inches, and the second size are 15x20 inches. There are also steam hammers for reducing extra large pieces so as to prepare them for the crushers. By their use something is saved in blockholing the large pieces in the mine. Electric lights have been put in, and water mains extended to this portion of the mine.

No. 2 shaft has direct-acting, double engines, 42x48 inch cylinders. Drum has 16-foot face and is 36 feet 6 inches in diameter. Each shaft has two hoisting engines, one for rock and men, and an auxiliary for handling timber, tools and men.

During the past few months small engines operated by air have been located on the 19th level to tram the cars to and from the shaft.

These are placed in the cross-cuts, and work on the endless rope system. Similar power trams will also be placed on the 20th and 21st levels. Five cars are handled at a time and a saving of fully 25 per cent is announced as compared to the hand-tramming. Cars hold 2 1-2 tons of rock each. In the hand-tramming three men are detailed to each car.

The company has a fine stamp milling plant, smelting works, rolling and wire mill at Dollar Bay. It also has an elaborate saw mill, and possesses valuable timber lands. It gives employment in mine and mills to 1,426 men.

Tamarack Junior Mine.

The Tamarack Junior Mine is on the same conglomerate lode as the Calumet and Hecla.

There are two shafts, No. 1 located on the most southerly forty and No. 2 on the forty next north.

A new shaft house has been erected at No. 2, and connection with No. 1 has been made by a trestle 1,000 feet long.

Osceola Mine.

The Osceola Mine is worked upon an old lava flow or melaphyr which like the conglomerate has been impregnated with copper, long subsequent to the successive series of flows and sea beach conglomerates, which piled one over the other, make up the Keweenawan formation.

There are three principal shafts, Nos. 3, 4 and 5, and No. 6, a new one, has been started.

No. 3, the most northern, is down to the 30th level.

No. 4 shaft is to the 32d level, two levels having been added in 1895.

No. 5 is to the 32d level, a distance vertically of 2,000 feet.

No. 6 was commenced in the spring of 1895, and has reached a depth on February 26, 1896, of 830 feet.

The mills of the company are located on Torch Lake and contain six heads of stamps, and an excellent general equipment.

The Wolverine Mine.

This is a melaphyr mine like the Osceola.

The lode is of a dull, brownish color, and much of the rock carrying the richest copper is a porous epidote of light green color.

There are four shafts. No. 1 is the most northern and is down to the 2d level. It is not in use, the ground being poor in that end of the mine.

No. 2, 400 feet south of No. 1, is to the 13th level. No. 3, 700 feet south of No. 2, is to the 11th.

No. 4 is a two-compartment shaft, recently commenced, and is 1,400 feet south of No. 3.

The number of men employed is 165 and the product of refined copper for 1895 was 1,815,381 lbs. The yield for 1894 was 1,656,255 lbs. The yield of copper per ton of rock treated is 21.08 lbs.. or 1.05 per cent.

The Kearsarge Mine.

This is on the same lode as the Wolverine.

There is one shaft known as No. 2, a single-skip, that is down to the 17th level.

The yield of refined copper per cubic fathom of rock broken is 409 lbs.

The Tecumseh Mine.

This mine comprises 520 acres in sections 32 and 34 in town 33, range 56. At this point they are sinking a vertical shaft to find the Osceola amygdaloid.

The Franklin Junior Mine.

This tract, consisting of 1 359 acres, stretches two and one-half miles across the mineral range, and has a surface length on the trend of the formation of about 7,000 feet.

The property is crossed by the prominent copper bearing lodes of this district.

At the Pewabic shaft there is a new equipment of machinery, two boilers, a double cylinder hoisting engine and air compressor.

The Franklin Mine.

The company has reached the line of the Quincy mine in their shafts at a depth of 3,000 feet, and beyond this it cannot go. It is mining on the 32d, 34th, 35th and 36th levels in the lower portion of the mine, and in the 9th and 10th levels of the upper portion.

The Franklin is working upon the melaphyr lode upon which, immediately south, is located the Quincy mine. The dip of the lode is 52 degrees to the northwest. The company has developed it entirely across the property, and has two shafts now open to the bottom of the mine, these being inclined with the formation.

The rock is run by gravity from the shafts to a stamp mill located at the foot of the steep hill, on the north shore of Portage Lake, thus affording a ready and cheap means of transportation.

The Quincy Mine.

This is south of the Franklin, and its landed possessions surround the Franklin upon all sides excepting the east. It has been producing copper for the past forty years and has given substantial proof of its richness by distributing $7,670,000 in dividends, besides which it has credit for a surplus of $1,007,500.68

The Quincy is opened on a brownish, dark colored melaphyr belt, possessing a great width, probably nearly 200 feet, and in the mineralized portion of this the work of mining is prosecuted. There appear to be two belts of copper-bearing character in this formation, one being known as the "main vein," the other as the "east branch," the latter apparently occupying a position in the footwall. In the course of mining it is shown that there are many barren stretches of ground, and there is also considerable variation in the thickness of the copper-bearing material. In places it may be forty feet, and then may pinch to three or four. They simply take as much of the melaphyr belt as is profitably charged with copper.

The copper-bearing portion of the lode will probably average a thickness of twelve feet.

The mine is fortunate in the large amount of mass copper it produces, this running from the size of a man's fist to pieces weighing many tons.

The strike of the Quincy lode is a very regular one, being north of east and south of west. The lode dips to the northwest at an angle of about 50 degrees, the lower workings at some places in the mine showing a little flatter angle, but as there is considerable waving of the footwall, the dip may not vary as much as is commonly supposed. Sometimes the shafts are in the lode, at times on one side, and then again upon the other, due to the rolling of the formation. The shafts are located on the top of a hill that rises to a height of about 700 feet above the level of Portage lake. They are three in number, being sunk in the lode, following the inclination of the latter.

No. 4 shaft is the most southern and is 30 feet below the 47th level, one level having been added in 1895. It is east of the main lode and a cross-cut is now being driven to connect it with this portion of the mine.

No. 2 shaft is 600 feet north of No. 4, and is to the 48th level, having been sunk 30 feet below the 46th in 1895.

No. 6 shaft is 1,900 feet north of No. 2, and is 30 feet below the 45th level, having been sunk from the 43d level during the year.

The walls of the lode are generally so firm that no timber is needed to sustain them, but occasionally, where the lode is of extraordinary width, it is employed.

Nearly all the drilling is performed by machines, No. 2 Rand. A little hand drilling is done in places.

The rapid handling of the men at this property is one of the attractive features. Formerly they were sent into and out of the mine on the old-fashioned man engine; this required considerable time to take care of the men. Now they are lowered and raised in a man car, and the entire force underground, about 400 souls, can be gotten in or out of the mine in thirty minutes. The man car bears a close resemblance to a section of a flight of stairs, the under side of which is provided with wheels that rest upon the rails of the shaft track. There are banisters on this section of stairs to prevent the men from being crowded over the sides. They take their seats on the steps and are gently lowered into the earth a distance on the incline of about 4,000 feet. There is no jerking or jolting, no unpleasant sensation. Thirty men are carried at a load, and the different shafts are all equipped with this convenience. The change from the skips to the man cars is made at each shaft in less than two minutes. Two 5-ton cranes are located in each shaft, one on either side of the skip-way, and with these the skips are lifted off and the man cars substituted in the time given.

A new shaft house has just been completed at No. 4 shaft. It is 30x89 feet and 72 feet high. At this shaft the company has increased the size of the old engine house by an addition of 16 feet, and installed a second engine. The old drum is increased from 18 to 22 feet in diameter, and is now in shape to do hoisting from a depth of several hundred feet beyond the present lowest levels.

At No. 2 shaft there is a magnificent new hoisting plant. It consists of a pair of 48x84 inch engines connected to a steel drum 26 feet in diameter with 12 1-4 foot face, having capacity for 7,500 feet of 1 1-2 inch rope. The governor is regulated to prevent a speed of over 3,000 feet per minute, and the skip is prevented from going too high in the shaft house by an automatic arrangement that shuts off steam, reverses the engine and applies the brake. The plant is a substantial, sensible one, and is contained in a stone building 58x94 feet·

A new brownstone supply house has been erected at No. 2 shaft and additions made to machine and blacksmith shops. The latter are models of neatness, as, indeed, are all portions of the surface. The company builds its own skips, power drills, and has a complete machine and smithing equipment.

The Quincy Mining Company has credit for one of the finest stamp mills on the lakes. It is of modern construction, and a very economical arrangement for the treating of rock is possessed. There are five Allis heads. There are six miles of railway connecting the mine and mill, the track being narrow gauge. There are three mogul engines and fifty 17-ton cars. The location of the mill is on Torch Lake.

The average number of men employed during the year was 968, of which 336 were miners, who earned an average of $50 per month.

The number of tons of rock broken was 563,360; tons hoisted, 506,058; stamp rock treated, 495,402 tons.

The product of mineral from stamp mill was 14,670,530 pounds; from rock houses, 5,062,440 pounds. The amount of refined copper was 16,304,721 pounds.

In 1894 a tract of 640 acres of mineral lands was purchased.

The Atlantic Mine.

The location of this mine is three miles southwest of Houghton on ground elevated several hundred feet above the lake's level. This mine has been one to which no little attention has been directed by reason of the excellent results achieved in its operation, it being credited with a net earning of about $900,000, this being won from a rock yielding an average of less than three-quarters of one per cent. of copper. For the year 1894 the yield was 14.06 pounds of copper per ton of rock, and the gross value of product per ton of rock treated was $1.3376. At this low yield, and with a low price for the product, the mine earned $48,762.95 in 1894. When it is considered that this rock has to be all drilled and blasted, the ground timbered, water pumped, the rock raised from a depth of over two thousand feet, put through crushers, run into cars and transported by railway nine miles, then to be stamped and otherwise treated in the mill, and all this for less than $1.34 per ton, none will dispute the fact that there must be an active management, and one well skilled in the different branches of the mining and milling business. In 1895 the percentage of copper per ton of rock was .73, and cost of mining, milling, etc., less construction account, was $1.2034 per ton.

The Atlantic is open on a melaphyr belt of dark-brown color, the mineralized portion of which has an average thickness of 15 feet. The copper in this is very evenly distributed. There are few barren stretches, and few rich bunches. There can be no selecting of the rock, and all the mineralized lode is sent to surface, no attempt at selection being made.

There are four shafts located on the lode, and the latter has been opened for a distance of 4,800 feet, No. 4 being the most southern. It has reached the 22d level. No. 1, the most northern, is to the 16th level; No. 2 is to the 20th; No. 3 to the 25th, 2,100 feet from surface.

What is known as the "New No. 3," is now to the 24th level.

The dip of the bed is about 55 degrees to the northwest, and the trend of the lode is more westerly than any of the lodes of this section.

At the mine there is a new boiler house, 88x66 feet. This contains a battery of eight boilers, of 100 horse-power each.

A new stamp mill has been built for the Atlantic Mine on the shore of Lake Superior at the mouth of Salmon Trout River.

Its dimensions are 151x234 feet, framed, with stone foundation and contains six heads of stamps, 18 inch, of the Ball's type, fifty-four iron Collun jigs, one 14x22 inch Reynolds-Corliss engine, a Gardner fire pump, lathes, pipe, bolt and nut cutters, planer, etc., making in all a fine equipment. There is a boiler house, 101x71 feet, containing three 16x6 foot Evans fire box boilers with Gardner duplex feed pumps, and a fire pump of same make. The smoke is conducted in a steel flue 175 feet long and 7 feet in diameter, that has been laid to a stone base on the hill back of the mill, which is surmounted by a smoke stack 30 feet high and 6 feet in diameter.

There is no pumping required to supply the water needed by the stamps. The water comes into the mill by gravity. A dam has been constructed across the Salmon Trout river, and the water from this is conveyed to the mill, a distance of 2,052 feet, being given a fall of 5 inches in each 100 feet. This dam cost the company over $20,000. It is constructed of timber, loose rock and earth. The main portion is crib work 53 feet thick at the bottom and 28 feet thick at the top, and 50 feet high. The length across the stream at the bottom is 51 feet, and at the top 228 feet. The crib work is of hewed flat timber 14 inches thick and bound together at the joints with inch square drift bolts. Loose rock was used for filling the cribs. The supply launder is 18x36 feet, which discharges into a steel tank 8 feet in diameter and 10 feet high, from which the water is conveyed to the stamps as needed. This water supply is a point of greatest importance to the company. When one considers that thirty tons of water are used in the washing of a single ton of rock, and that this company treats about 1,000 tons of rock daily, the value of the new plant can be readily recognized.

During 1895 the company stamped 331,058 tons of rock.

The mill is eight and one-half miles from the mine, and the company has connected the two by a standard-gauge railway. They have an ample equipment of locomotives and cars. There is one large consolidation engine, a Brooks, with four drivers, and weighing 90 tons, besides which there is a 45-ton Brooks, and two 20-ton locomotives. There are 32 flat cars and 127 rock cars, the latter having a capacity each of 5 1-4 tons.

The product of refined copper for 1895 amounted to 4,832,497 pounds, an increase over the production of the previous year of 605,112 pounds. The total production of refined copper to date is 72,048,632 pounds. The gross profit for 1895 was $110,559.47. The net surplus December 31, 1895, was $150,874.97. The number of men employed at mine and mill is 476.

KEWEENAW DIVISION.

The Central Mine.

This mine is worked upon a true fissure vein.

ONTONAGON DIVISION.

In this district there are working the Knowlton, Mass, Minnesota, National and Ridge.

This district is the first that was actively worked for copper and masses weighing 200, 300 and over 500 tons have been found.

IRON RANGES.

MARQUETTE RANGE.

Has a length of 40 miles by from 6 to 12 miles. Has shipped 43,937,510 tons, 2,095,166 in 1895.

BUFFALO MINES.—450 feet in depth. Use caving system and is a fine place to see it operated, 4 mines in fact; about 400,000 tons annually produced, fine machinery, underground haulage system, endless rope.

NEGAUNEE MINE.—1 shaft 486 feet deep. Mine in square sets. A very interesting property to visit. Fine plan of ore sampling. New hoisting plant to be installed in 1896.

JACKSON MINE.—Oldest in the State, has 2 shafts 300 feet deep. Needs no timber. Hard and soft ores occur indiscrimately, a peculiar formation.

CAMBRIA MINE.—2 shafts 570 feet deep. Mine 40,000 tons annually. Use square sets. Formation rolls and twists erratically, and requires fine engineering to properly follow.

LILLIE MINE.—2 shafts 300 and 350 feet deep. Win the ore by caving the surface and slicing the ore off in horizontal sections. Have an 8 foot hoist. Three hundred men are employed.

LAKE SUPERIOR IRON CO.—Has been running since 1858, and has produced 6,734,472 tons of ore. It mines both hard and soft varieties and observes all the principal methods in its extraction. Its deepest workings are 920 feet. It has four mines, all of which are equipped with modern machinery.

THE PITTSBURG AND LAKE ANGELINE IRON CO.—The Lake Angeline mines, two in number, are interesting and important and enjoy a national reputation for the fine quality of their ores. The caving system of winning ores is employed in their soft hematite deposits. They mine both hard and soft ores. These mines were the first to introduce electric haulage machinery for the underground transportation of ore. They have an electric motor handling ten two-ton cars. Dynamo is 85 horse power. Voltage 500. A large territory has been opened up. Eight hundred men are employed, and the mine produced 350,000 tons in 1895, making a grand total of 3,352,561 tons. All portions of the mine are finely equipped with modern machinery.

THE CLEVELAND CLIFFS IRON MINING CO.'S.—The Cleveland mine is opened up under the bottom of Lake Angeline, the waters of which (800,000,000) gallons have been pumped out. On the ore depost lies 40 feet of sand and overlying this is forty feet of mud. The latter has threatened the mine but it is effectively worked and the immense mass of mud successfully coped with. There are 76 rooms opened on the first level, a length of 2,760 feet. In the second level there are 72 rooms, in the third, which is but partly opened, 14 rooms. They work one level at a time, from the top down. An open pit 400 feet long by 80 feet wide is now worked. A new mine on the south side of the old lake basin is being opened up. There are two electric motors, one of thirty, the other of sixty-horse power. The electric generator is 4-pole, 100 kilowats, 220 volts, 600 revolutions per minute. This power operates the underground tramming railway, where there are about 5,000 feet of track At the Lake Shaft mine is a new plant of machinery—cross-compound engines, 22 inches and 32x48 inches, Corliss condensing, with 12 foot first motion drum, equipped with hydraulic brake. Air compressors are Rand, 16x32 inches, duplex. The finest mill in the United States for framing mine timber is here. The operators of this also own and operate the Cliff Shafts, Moro and Incline Mines, yielding hard ore, and the Salisbury mine yielding soft ore.

Ore crushers weighing 82,000 pounds, with openings 18 inches by 24 inches are used. All mines of this company are thoroughly equipped and their annual product is 600,000 tons.

The furnace plant of the Cleveland Cliffs Co., located at Gladstone. Delta Co., Mich., are of the finest. Charcoal is the fuel used. The producing capacity is 130 tons daily. Bosh 12 feet, hearth 7 feet, stock line 8 feet, bell 5 feet. The stove plant has two Cowper stoves 16x70, each stove having 16,900 square feet heating surface. Casting house is 50 feet by 115 feet 2 inches. There are forty 65-cord kilns requiring 125 cords daily. A chemical plant for securing alcohol and other by-products from the consumption of wood is operated. The finest in America.

Excelsior blast furnace, Ishpeming, 60 tons daily, newly rebuilt.

WINTHROP MINE—is working the longest open pit in this country dislodging thousands of tons of ore at a single blast. Stripping drift with steam shovel.

REPUBLIC MINING CO.—The Republic mine, renowned for purity of its product, has been opened for a length of 3,000 feet. Has three shafts now working. Greatest depth 1,200 feet. Produces hard, specular, and magnetic ores. Power to operate machinery furnished by water power on Michigamme river. Has shipped 4,251,026 tons ore. Has four 14-foot drums at Nos 1 and 8 shafts. A "Cornish lift" takes care of the water.

THE CHAMPION MINING CO.—The Champion mine has 4 shafts, working on a lode 2,000 feet long, greatest depth 1,200 feet. Specular and magnetic ores produced. Has dike crossings, two lodes of ore, and is very interesting geologically. Two 55-ton ore crushers worked and another to be added. Openings of jaws 24 inches by 24 inches, and operated by manilla rope transmission on 10-foot pulleys. Ore going from shafts to crushers by gravity. Have four 14-foot drums, 7 foot face, and a compressing plant with 30x48 in air and 28x48 in steam cylinders. Fine shops.

ROPES GOLD MINE.—One shaft, 800 feet deep. Mine 700 feet in length worked on a series of segregated veins. Has produced $605,-056.95 worth of gold and silver. In the serpentine formation. Mill with 65 Cornish stamps. Frue vanners and perfect amalgamation plant.

MENOMINEE RANGE.

Has a length of 45 miles by from 4 to 15 miles—has sent out 18,528,827 tons, 1,694,804 in 1895.

VULCAN MINE.—Two shafts 1,000 feet deep. Very interesting geologically. Two strata of ore—much jaspilite. Rooms are rock-filled. Tramming rock done with mules. Worthington pump at 12th level, compound-condensing with 25 horse power high-pressure cylinders 43 3-10 inch low pressure, four 12 inch poles, 36 inch stroke. One thousand gallons per minute, in 1,000 feet left under 60 lbs. steam pressure.

ARAGON MINE.—Three shafts, to 7th level or 586 feet. The ore is mined in square sets, and the rooms filled with sand run in from the surface. New hoisting plant will be put in in 1896. The company is sinking a new shaft.

CHAPIN MINE.—Two thousand five hundred feet long, and 70 feet in thickness. Four principal working shafts, from 600 to 800 feet deep. Two lodes of ore. Produce 650,000 tons annually; 1,300 men employed Caving system generally used but some square set work is done. At B and C shafts there is a pair Corliss engines 30x60 inches, with conical drums, with an average diameter of 12 1-2 feet, and capacity for 1,500 feet of 1 3-8 inch wire rope.

D shaft has a pair 24x48 inches Corliss engines operating two flat rope reels holding 1,500 feet of 1-2x4 inch steel rope. Pumping plant at D is one of largest mine pumps in world:—steeple compound—50 inch initial cylinders; 100-inch low preassure; 120-inch stroke; plunger 28 by 120 inches; capacity 3,000 gallons a minute with a 1,500 feet lift.

Hydraulic power is used to operate all the mine plant but the big pump. This power is obtained from falls on the Michigamme river some three miles from the mine where four large compressors are placed. Power trams are used underground, also 150 power drills. The mine has a saw-mill for framing timber, is lighted by electricity and also has fine shops. The Ludington and Hamiliton mines have been lately purchased by the Chapin Co. Hamiliton has a flat rope hoisting plant with 10 ton skips. The mine is 1,460 feet deep.

PEWABIC MINE.—Three shafts, to 5th level; at each shaft are two 10-foot drums with direct acting engines 24 inches by 48 inches. The ore is mined on the square set plan but the company has a different system of slicing pillars than the other mines.

Finest underground pump in the country, a Worthington, triple expansion, cylinders, 15 inches, 23 inches and 38-inch by 12-inch plunger, 24-inch stroke. Supplied with surface condenser, capacity 1,500 gals. per min., 700 feet lift with 125 lbs. of steam. Fine system of sampling ores, with interesting occurrences of phosphorus and perplexing geological features. Produces the finest ore of any mine in the world—giving 68.60 per cent. iron, .007 per cent. phos.

ANTOINE ORE CO.—Mining high silicon—low iron ores, from open pits. Crushing ores. Crusher 30 inches by 30 inches.

COMMONWEALTH MINE.—Use no timber, hanging firm, hoisting from immense stopes 250 feet high—none other like it in the district.

DUNN MINE.—Use no timber, hanging firm; hoisting from sub-shafts from underground levels direct from surface plant by neat arrangement of pulleys, etc. Fine plant.

COLUMBIA MINE.—Two shafts—mine very wet, little or no timber used, two lodes of ore.

HEMLOCK MINE.—Has two shafts, 290 feet deep. Three modes of winning ore, large open stopes with no timber; drift sets and caving and on square sets.

GOGEBIC RANGE.

Has a length of 45 miles by 3 miles in width, has sent out 16,395,375 long tons, 2,560,775 in 1895.

NORRIE MINING CO.—The Norrie Mine produces 800,000 gross tons iron ore annually—greatest iron mine in the world, Ore deposit one mile long, and reached by 12 shafts. Lode 60 feet to 300 feet wide, 800 feet deep at present. One thousand three hundred men employed, two hoisting stations 10 feet drums, Prescott pumps; electric signals and lighting, square set system of timbers.

AURORA MINE.—Two hundred and fifty thousand tons annually, 4 shafts 600 feet deep. Opened 2,500 feet long, caving pillars, 3 hoisting plants 8 feet drums, a 50 drill Ingersoll Compressor, and electric lights. Employs 345 men. Square set system of timbering.

ASHLAND MINE is opened for 2,500 feet in length, 8 shafts, caving pillars, well equipped.

PABST MINE.—Two hundred and twenty-five thousand tons annually, 5 shafts, opened 1,900 feet in length and from 60 to 300 feet in width. Five hundred feet deep. New hoisting plant with 24 inch by 48 inch engine connected by a 14 foot gear wheel to a pair of 10 feet hoisting drums made by Webster, Camp & Lane. Complete equipment with compressors, etc.

NEWPORT MINE.—Manganiferous iron ore, from 10 to 40 per cent. Six shafts. Deposits 2,000 feet long. Employs 200 men. One hundred and fifty-seven thousand eight hundred and twenty-one tons of ore produced in 1895. Timbering in square sets. Complete equipment.

TILDEN MINE.—Six shafts 700 feet deep. Mine 4,000 feet in length. Annual product 500,000 tons. Uses the "drawing" system of winning the ore. One 12 foot hoist, one of 6 feet, and has one 6-foot 60 drill air compressor. Employs the incandescent system lighting, and fine shops.

PALMS MINE.—Three shafts 500 feet deep. Deposit 1,800 feet long. New 8-foot hoisting plant.

BROTHERTON MINE.—Three shafts 400 feet. The mine secures the ore by the caving or "North of England" system.

ORE DOCKS.

MARQUETTE.—D., S. S. & A. Ry. Three docks, 700 pockets, capacity 100 tons each. Marquette, Lake Superior & Ishpeming Ry., 1 dock 1,200 feet long, 300 pockets, 100 tons each.

ASHLAND.—Three docks with capacity of 101,500 tons ore.

GLADSTONE.—One dock, 16,000 tons.

ESCANABA.—Five docks, capacity 151,218 tons.

Owing to lack of space only part of the mines, of the various districts have been enumerated, and most of them only briefly described.

BUILDING STONE, ETC.

Michigan contains a vast amount of sandstone suitable for building purposes, the finest varieties being found in the upper peninsula, on the shores of Lake Superior, near Keweenaw Bay. Here it can be readily quarried and transported to Chicago, Cleveland, Buffalo, and other distributing centers on the great lakes.

The varieties most popular with builders are the brown, rain-drop and red, these generally differing only in their markings. The brown is of the richest, and it has been principally secured from quarries at Marquette, Mich. The supply has steadily grown less, and but limited quantities can now be furnished. Some of the finest buildings in Michigan, as well as other states, are constructed of this stone.

THE KERBER-JACOBS REDSTONE COMPANY is one of the best known of the producers of sandstone in the State.

THE PORTAGE ENTRY QUARRIES COMPANY is one of the oldest sandstone producing concerns on the lakes. As indicated by their title, their principal quarrying is done at Portage Entry, where they have a complete plant for securing the stone rapidly. They also operate the Marquette quarries. The amount produced from the latter in 1895 was 38,014 feet, and from Portage Entry 181,511 feet, in all 219,525 feet.

THE EXCELSIOR REDSTONE COMPANY, is quarrying stone on the shores of Portage Lake, making their first shipment in 1894, the true sheet having been located after a years systematic exploration. The thickness of the marketable strata averages about 8 feet, and the quality of the stone is of the finest. The overlying burden varies in thickness according to location, showing about 21 feet at the present point of operations.

An average of 60 men are employed. The present equipment con_ sists of 3 steam pumps, 1 steam channeling machine, 2 steam drills, 1 steam hoister, 1 boiler 170-horse power, 1 derrick, 20 tons capacity. Besides this there is a well-equipped blacksmith shop, and three miles of railroad from the quarry to the lake shore, equipped with a locomotive and 30 flat cars.

The product in 1894 was 18,000 cubic feet, in 1895 45,000 feet.

THE L'ANSE BROWNSTONE COMPANY is a new one in the brownstone producing business, having made its sample shipment of about 2,000 feet in 1894. Its quarry is at L'Anse, and it was worked in 1895 for five months and 23,000 cubic feet of stone quarried. The greater portion of this was of the brown variety. A force of 34 men was employed. The equipment consists of 1 two-power, 15-ton hoist geared for two derricks, 1 24-horse power engine, two Ingersoll-Sergeant steam drills, 1 bar channeler, 2 Wardwell channelers, 1 Worthington pump, 1 Lidgerwood double-drum hoist, 1 core drill, engine, boiler and fittings, 1 set Lidgerwood's friction drums worked by gravity for letting down cars from quarry to dock, a distance of 1,500 feet. The loaded car brings up the empty one. Another derrick is now being put up in the quarry.

THE TRAVERSE BAY REDSTONE COMPANY.—This company is operating in Houghton county, T. 56, R. 31, and has shown sandstone of excellent quality covering 120 acres. It has constructed eight miles of three-foot railroad, from the quarry to the bay, and has a dock 1,000 feet long at the latter place. The work of 1895 was devoted almost entirely to developing and equipping, 6,500 feet of stone being all that was quarried. There are two hoists with boilers, two derricks, and a full equipment of machinery for cutting stone.

Waverly Stone.

This stone is of a bluish-gray color, uniform in its appearance and texture, and makes a handsome stone for building purposes. It is found at Holland, Ottawa county, and takes its name from similar stone that is quarried in large quantities at Waverly, Ohio. The Michigan stone is free from iron stains that present such objectionable appearance in this stone from other places.

Grindstones.

Huron county has been a producer of grindstones and whetstones for more than forty years. The location of the quarries is at Grindstone City, on the shores of Lake Huron, twenty-four miles northeast of Bad Axe. the county seat, and ninety miles above Port Huron. Lake Huron blue stone is known in every market in the United States, and is also recognized abroad. In grindstones and scythe stones the supply is not equal to the demands of the trade,

Novaculite.

This stone, and of a very fine grain, suitable for hones, occurs in Marquette county, near the cities of Marquette and Negaunee.

Slate.

There are large deposits of slate in Baraga county, and considerable attention was given to its quarrying several years since.

Limestone.

Limestone is generously distributed throughout the entire State of Michigan. The manufacture of lime is carried on at several points, Bellevue being noted for its fine product. The stone is also used for building purposes.

Quartzite.

There are vast deposits of this rock in the northern portion of the state, gannister being quarried for the lining of blast furnaces.

Clay.

Clay is found in nearly every county in the State. Near Detroit a deposit suitable for the manufacture of pottery is operated. The manufacture of brick and tiling is conducted at many places, and provides employment to a large number of men.

Granite.

This stone exists in immense areas throughout the northern portion of Michigan, but at no point is it quarried. Near Marquette is a fine variety suited to building purposes.

Asbestus (Chrysotile).

Long ago the variety of serpentine known as chrysotile, which is used for asbestus, was found in association with the serpentine rocks north of Ishpeming, in Marquette county, on sections 29 and 30, town 48, range 27. It possesses a fine fibre of from one inch to one inch and a half long, and compares favorably with the Canadian product, which supplies the greatest portion of the amount of this mineral consumed in the United States.

Gypsum.

The principal gypsum producers of Michigan are now represented by the Michigan & Ohio Plaster Co.

The following concerns were active in 1895:

NAME.	LOCATION OF MILLS.
Alabastine Company	Grand Rapids Mich.
Grand Rapids Gypsum Works	" " "
Grand Rapids Plaster Co.	" " "
F. Godfrey & Bro.	" " "
Gypsum Plaster and Stucco Co.	" " "
Loren Day	" " "
Western Plaster Works	Alabaster, Mich., and South Chicago.

The product of the above named companies was as follows:

Calcined Plaster, tons	52,700
Land plaster, tons	10,600
Gypsum rock, crude	12,000

The gypsum product of Michigan is noted for its purity, and the supply is equal to meet the severest call that can be made upon it.

Talc.

This mineral is found in the serpentine range of Marquette county, and preparations are under way for its mining. Adjoining the property on which is located the Ropes gold mine, a large vein has been found, and can be cheaply worked.

Marble.

Michigan has only one marble quarry that is being operated at this time. The single quarry now showing activity is located in Dickinson county, on Sec. 26, 42, 28, and is operated by the Northern Michigan Marble Company.

The stone is a very bright, sparkling, crystalline carbonate of lime, hard and tenacious, making it desirable for building or monumental purposes. Some of it is pure white, some variegated, shading from white to pink, green, gray and purple, making beautiful slabs for wainscoting and interior work.

There is a pressing demand for the stone beyond anything the company can supply, even the chips and small spals being disposed of.

The Serpentines.

They are among the most beautiful of the rock creations when they contain dolomite, the blending of the two forming what is known as verde antique.

The Michigan serpentine outcrops at Presque Isle, near Marquette, this being the most easterly point at which it is seen. It disappears from view going west, and again is seen fifteen miles east on Sec. 27, 48, 27, a few miles north of Ishpeming. Prominent ridges show for about four miles when it again sinks from view.

COAL.

Although several counties in the southern and central portions of Michigan are underlaid by detached basins of the Central coal field, there is but little being done in the way of coal mining.

The coal being mined is of a semi-bituminous character, is excellent for steaming and fuel purposes, and crude tests made of the recently discovered beds in the Saginaw valley indicate it to be valuable for the manufacture of coke.

The Corunna Coal Co., whose mine is located near Corunna, Shiawassee county, worked part time during 1895, producing 12,241 tons. About 60 men were employed. The mine can produce 150 tons per day.

The Sebewaing Coal Co., located near Sebewaing, Huron county, was the only one working continuously throughout the year, it sending out 38,523 tons, and giving employment to 75 men.

The Saginaw Bay Coal Co., closed their mines early in 1895 and are not expecting to resume. The mines had been operated about four years and produced about 10,000 tons annually.

The Bennett Sewer Pipe Co., of Jackson, has closed its mines, and the New Coal Mining Company, of the same place, has also abandoned its workings.

Michigan reached its maximum output in 1882 when 135,339 tons were produced, but in no year since has the output exceeded 81,500 tons.

The following is the total product of the State in tons of 2,000 pounds, for the past four years:

	1892	1893	1894	1895
Total product..........	77,990	45,979	43,780	50,764

SALT.

Michigan ranks first in the states in its production of salt. In 1895 there were made 3,529,312 barrels. For the year 1894 the United States produced 12,967,417, and the mineral is one very generally distributed throughout the Union.

The salt producing territory of Michigan is an immense one, and constant additions to the former salt-giving area are made.

Many of the salt works are operated in connection with saw mills, and the refuse from the manufacture of timber and shingles is used for fuel in evaporating the salt brine. Due to this practice the manufacturers have been enabled to make a small profit even at the very low price quoted for the salt which in 1895 was but 48 9-10 cents per barrel, this including the cost of the barrel.

The salt producing territory of the State is divided into nine districts, having manufacturing capacity as follows:

District No. 1, Saginaw county, has forty-two salt companies, with forty steam and three pan blocks and four thousand solar salt covers, having a manufacturing capacity of one million three hundred fifty thousand barrels of salt.

District No. 2, Bay county, has twenty-nine salt companies, with thiry-two steam blocks, one vacuum pan, and with a manufacturing capacity of one million three hundred thousand barrels of salt.

District No. 3, Huron county, has four salt companies, with one steam and three pan blocks and with a manufacturing capacity of three hundred thousand barrels of salt.

District No. 4, St. Clair county, has ten salt companies, with six steam and four pan blocks and with a manufacturing capacity of six hundred thousand barrels of salt.

District No. 5, Midland county, has two salt companies, with two steam blocks, having a manufacturing capacity of seventy-five thousand barrels of salt.

District No. 6, Iosco county, has six companies with six steam blocks having a manufacturing capacity of three hundred thousand barrels of salt.

District No. 7, Manistee county, has ten salt companies with nine steam and two pan blocks having a manufacturing capacity of one million two hundred fifty thousand barrels of salt.

District No. 8, Mason county, has four salt companies, with two steam and two pan blocks, having a manufacturing capacity of five hundred thousand barrels of salt.

District No. 9, Wayne county, has one salt company with one salt block, having a manufacturing capacity of one hundred fifty thousand barrels of salt.

REGISTER OF STUDENTS

1894–1895.

GRADUATE STUDENTS.

NAME.	RESIDENCE.	ROOM.
Abbott, Ai Arthur, S. B. (Michigan Agricultural College), E. M. (Michigan Mining School),	Holt.	Mr. J. Edwards's.
Croze, Walter Wilfred Joseph, S. B. (Michigan Mining School),	Houghton.	Mr. Jos. Croze's.

CLASS OF 1895.

Barlow, Royce Elwin,	Hastings.	Mrs. P. Didier's.
Been, John Theodore,	Skanee.	Mr. J. Edwards's.
Cameron, William,	St. Louis, Mich.	Mr. P. Didier's.
Coleman, Milton Watson,	Devizes, Ont.	Stroebel's Block.
Davis, Carl Raymond,	Helena, Mont.	Mr. T. Lange's.
Dockery, Love,	Love, Miss.	Mr. T. Lange's.
DuBois, Wilbur Fisk,	Mobile, Ala.	Mr. C. Brand's.
Emlaw, Harlan Stigand,	Grand Haven.	Mrs. Healey's.
Esselstyn, John Nelson,	Lansing.	Mr. J. Edwards's.

NAME.	RESIDENCE.	ROOM.
Graves, MacDowell,	Detroit.	Keweenaw Club.
Hardenburgh, Louis Martin, A. B. (Hillsdale College).	Hillsdale.	Mrs. Burrows's.
Holbert, Henry Hoffman,	St. Clair.	Mr. J. Edwards's.
Kent, Bamlet,	Forest, Ont.	Stroebel's Block.
Martin, Nicholas John,	Virginia, Minn.	Mr. Grignon's
Monroe, William Dearborn,	Bath.	Mr. C. Brand's.
Murray, Robert,	Lake Linden.	Miss Kelly's.
Orr, John Forrest,	L'Anse.	Mrs. Burrows's.
Rose, Robert Selden,	Fond du Lac. Wis.	Mr. Haas's.
Schumann, Enrique Adolpho,	Santiago, Cuba.	Keweenaw Club.
Slock, George,	Houghton.	Mr. Slock's.
Stringham, Joseph, Jr.,	Saginaw, E. S.	Mrs. Didier's.
Upham, William Erastus,	Duluth, Minn.	Mr. T. Lange's.
Watson, John Bone,	Opechee.	Mrs. Brimacombe's.
Weatne, William, Jr.,	Red Jacket.	Mrs. Burrows's.
Wright, Louis Aldro,	Villa de Musquiz, Coahuila, Mex.	Mr. A. Haas's.

CLASS OF 1896.

NAME.	RESIDENCE.	ROOM.
Cavazos, Amado,	Saltillo, Mex.	Mrs. Brimacombe's.
Figueroa, Camilo, A. B. (St. Mary's College),	Saltillo, Mex.	Miss Kelly's.
Greene, Fred Turrell,	Berlin, Ont.	Mrs. West's.
Hoar, Frederic Walpole,	Houghton.	Mr. R. M. Hoar's.
Houle, Albert Joseph,	Negaunee.	Mrs. Healy's.
McDonald, Donald William,	Calumet.	Miss Kelly's.
Rashleigh, William John,	Houghton.	Mr. Jos. Rashleigh's.
Russell, Edward Francis,	Yonkers, N. Y.	Mr. C. Brand's.
Smith, Willard Joseph,	Allouez.	Miss Kelly's.
Snow, Arthur Eugene,	St. George, Utah.	Mr. J. Ehler's.
Sweet, Roy William,	Iron Mountain.	Mr. J. B. Pfeiffer's.
Trethewey, James Henry,	Lake Linden.	Mr. J. Trethewey's.
Walker, Elton Willard,	Detroit.	Mr. J. Edwards's.
Zertuche, Ygnacio Maria.	Monterey, Mex.	Mrs. Brimacombe's.

CLASS OF 1897.

NAME.	RESIDENCE.	ROOM.
Blackwell, Frank,	Norway.	Mr. H. Hooper's.
Carpenter, Alvin Bacon, Ph. B. (Beloit College),	Beloit, Wis.	Mr. T. Lange's.
Daniell, John, Jr.,	Opechee.	Mrs. Brimacombe's.

NAME.	RESIDENCE.	ROOM.
Derr, Homer Munro,	Ann Arbor.	Mr. J. Ehler's.
Dykema, Frank Leonard.	Grand Rapids.	Mrs. Healy's.
Floeter, Albert Henry Christopher,	Menominee.	Mr. J. B. Pfeiffer's.
Haas, Frank William,	Houghton.	Mr. J. Haas's.
Haas, Nathan,	Houghton.	Mr. D. Haas's.
Harris, George Henry Ronald, C. E. (Royal Military College, Kingston, Ontario),	London, Ont.	Mr. Grignon's.
Hoar, John Mitchell,	Houghton.	Mrs. E. M. Hoar's.
Klein, William Louis,	Detroit.	Betzler's Hotel.
Knox, John, Jr.,	Hamilton, Ont.	Mrs. Healy's.
Minehan, Michael Matthias, A. B. (St. Mary's College),	Summerfield, Kan.	Mr. C. Brand's.
Remington, Charles Stevens,	Syracuse, N. Y.	Mr. C. Brand's.
Sarazin, William George,	Lake Linden.	Butterfield House.
Van Orden, Frank Lyon,	Houghton.	Mr. M. Van Orden's.
Walker, George Washington,	Walker, Ill.	Keweenaw Club.

SPECIAL STUDENTS.

NAME.	RESIDENCE.	ROOM.
Allen, Thomas,	Hancock.	Mr. W. H. Allen's.
Bates, Arthur Walter,	Gaylord.	Butterfield House.
Brand, William,	Houghton.	Mr. C. Brand's.

NAME.	RESIDENCE.	ROOM.
Brown, William Francis,	New York, N. Y.	Mr. C. Brand's.
Burnham, Guy Chynoweth,	Hancock.	Dr. Burnham's.
Calhoun, Charles Andrew.	Albert Mines, Nova Scotia.	Stroebel's Block.
Gibbs, Frank Nicholson, C. E. (Royal Military College, Kingston, Ontario),	Port Arthur, Ont.	Mr. Grignon's.
Goodell, Horatio Stewart,	Houghton.	Mr. R. R. Goodell's.
Goudie, James Hunter, A. B. (Glasgow University),	Ironwood.	Butterfield House.
Hayen, Albert,	Hancock.	Mr. C. H. Hayen's.
Holmes, Edward Hyneman,	Flint.	Mr. T. Lange's.
Hooper, James Knight,	Crystal Falls.	Mr. C. Brand's.
Hosking, Charles,	Hancock.	Mr. G. Hosking's.
Hunt, Robert Courtney,	Houghton.	Mr. J. Hunt's.
Kennedy, John William,	Sharpsburg, Pa.	Mr. C. Brand's.
Martin, John Peter.	Houghton.	Mr. J. Martin's.
May, Albert Edward, A. B. (University of Minnesota),	Minneapolis, Minn.	Mr. A. Haas's.
McAskill, John Francis,	Hancock.	Mr. H. McAskill's.
McElery, Frank Jerome,	New York, N. Y.	Mr. C. Brand's.
Merry, Thomas Woodward,	Low Moor, Va.	Mrs. E. M. Hoar's.
Nichols, John Lawrence Darvall,	Cheltenham, England.	J. B. Pfeiffer's.

NAME.	RESIDENCE.	ROOM.
Parker, Warren Downs, Jr.,	River Falls, Wis.	Keweenaw Club.
Parks, Henry James,	Lake Linden.	Mr. C. Brand's.
Penberthy, John Edward,	Houghton.	Mr. E. R. Penberthy's.
Penberthy, Samuel Roy,	Hancock.	Mrs. M. Penberthy's.
Raymond, John Chester,	Houghton.	Mrs. Raymond's.
Reynolds, Frederick Llewellyn,	Pasadena, Cal.	Mrs. Healy's.
Richey, Appleton,	Houghton.	Mr. A. R. Richey's.
Rioux, John Elisor,	Dollar Bay.	Mr. A. Rioux's.
Sanders, Nicholas,	Hancock.	Mrs. E. J. Sanders's.
Shields, Irving James,	Hancock.	Mr. Shields's.
Slock, Anthony,	Houghton.	Mr. Slock's.
Sturgis, James Bennett, Jr.,	Houghton.	Mr. J. B. Sturgis's.
Sutton, William John,	Victoria, B. C.	Betzler's Hotel.
Thomas, James Arthur,	Houghton.	Mr. William Thomas's.
Truettner, Irving Willard,	Bessemer.	Mr. Grignon's.

REGISTER OF STUDENTS.

1895–1896.

REGISTER OF STUDENTS, 1895–1896.

NAME.	RESIDENCE.	ROOM.
Baker, Franklin Jr., S. B. (Lehigh University),	Philadelphia, Pa.	
Bates, Arthur Walter,	Gaylord.	Butterfield House.
Been, John Theodore,	Skanee.	Mrs. West's.
Blackwell, Frank,	Norway.	Mr. H. Hooper's.
Blair, Arthur Eddlumund,	Marysville, Mont.	Mrs. West's.
Boyd, Frederick James,	Dollar Bay.	Mr. F. J. Boyd's.
Brand, William Jacob,	Houghton.	Mr. C. Brand's.
Brown, William Francis,	New York, N. Y.	Mr. C. Brand's.
Burnham, Mathew Howard,	Johannesburg, S. Africa.	Mr. M. H. Burnham's.
Carpenter, Alvin Bacon,	Beloit, Wis.	Mrs. West's.
Carpenter, Guy David,	Blissfield.	Mr. J. Edwards's.
Cavazos, Amado,	Saltillo, Mex.	Mrs. Brimacombe's.
Clark, Alonzo Webster, Jr.,	Detroit.	Keweenaw Club.
Colton, John Dudley, 2nd,	Longmeadow, Mass.	Mr. J. Thomas's.

NAME.	RESIDENCE.	ROOM.
Cooke, Harry Arthur,	Caspar, Wyo.	Mr. T. Lange's.
Cornell, Roscoe,	Dillon, Mont.	Mrs. West's.
Croze, Charles Edward,	Houghton.	Mr. J. Croze's.
Cruse, Josiah Alfred,	Ripley.	Mr. J. Cruse's.
Curtis, George Doyle,	Butte City, Mont.	Mr. T. Lange's.
Daniell, John, Jr.,	Houghton,	Mr. J. Daniell's.
Daniell, Richard Ernest,	Houghton.	Mr. J. Daniell's.
DuBois, Wilbur Fisk,	Mobile, Ala.	Mrs. West's.
Duncan, William	Calumet.	Mr. John Duncan's.
Dunn, Bird Wallace,	Houghton.	Capt. W. Dunn's.
Edwards, Robert Leverich,	Houghton.	Mr. T. W. Edwards's.
Esselstyn, John Nelson,	Lansing.	Mrs. West's.
Farmer, Frank,	Georgetown, Colo.	Miss Kelly's.
Fay, Louis Douglas,	Chicago, Ill.	Mrs. E. M. Hoar's.
Fechheimer, Solomon,	Chicago, Ill.	Mrs. West's.
Fisher, Charles Gotfried,	Hancock.	Mr. Fisher's.
Floeter, Albert Henry Christopher,	Menominee.	J. B. Pfeiffer's.
Formis, Andre,	Stuttgart, Germany.	Keweenaw Club.

NAME.	RESIDENCE.	ROOM.
Gilbert, Edwin Gage,	Winnetka, Ill.	Mrs. West's.
Goulette, John,	Hancock.	Mr. Chas. Goulette's.
Graves, MacDowell,	Detroit.	Keweenaw Club.
Greene, Fred Turrell,	Berlin, Ont.	Mrs. West's.
Haas, Frank William,	Houghton.	Mr. J. Haas's.
Haas, George Allen,	Houghton.	Mr. A. Haas's.
Haas, Nathan,	Houghton.	Mr. D. Haas's
Hall, Edward John,	Central Mine.	Mrs. Didier's.
Hardenburgh, Louis Martin, A. B. (Hillsdale College),	Hillsdale.	Mrs. A. Burrows's.
Harris, George Henry Ronald, C. E. (Royal Military College, Kingston, Ontario),	London, Ont.	Mrs. West's.
Hartmann, William Frederick,	Houghton.	Mr. G. Hartmann's.
Hicks, William Charles.	Houghton.	Rev. W. C. Hicks's.
Hoar, Frederick Walpole,	Houghton.	Mr. R. M. Hoar's.
Hoar, John Mitchell,	Houghton.	Mrs. E. M. Hoar's.
Hodgson, Joseph, H.	Houghton.	Mr. J. Hodgson's.
Hodgson, William Adams, S. B. (Michigan Mining School),	Houghton.	Mr. J. Hodgson's.
Hooper, James Knight,	Crystal Falls.	Mr. C. Brand's.
Houle, Albert,	Negaunee.	Mrs. Healy's.

NAME.	RESIDENCE.	ROOM.
Jeffs, Louis Albert,	Rockland.	Mrs. Brimacombe's.
Jenkin, Joseph Henry,	So. Lake Linden.	Mrs. A. Harris's.
Jennison, Ernest Newton,	Dollar Bay.	Mr. S. S. Jennison's.
Keeler, James Roland,	Blissfield.	Mr. J. Edwards's.
Kent, Bamlet,	Forest, Ont.	Oriental House.
Knox, John, Jr.,	Hamilton, Ont.	Mrs. Healy's.
McCurdy, William Alexander,	Houghton.	Mr. Wm. McCurdy's.
McDonald, Donald Wm.,	Calumet.	Miss Kelly's.
McElery, Frank Jerome.	New York, N. Y.	Mr. C. Brand's.
Mercer, Harry Talman,	Ontonagon.	Mrs. Brimacombe's.
Millard, James Harvey,	Bear Lake.	Stroebel's Block.
Minehan, Michael Matthias, A. B. (St. Mary's College),	Summerfield, Kan.	Mr. J. Cameron's.
Munroe, William Dearborn,	Bath.	Mrs. Trim's.
Ogorek, Leopold,	Scharley, Prussia.	Mr. C. Brand's.
Oliver, Thomas,	Norway.	Mr. H. Hooper's.
Osborne, Nathan Sanford,	Water Mill, N. Y.	Mrs. A. Harris's.
Parker, Warren Downes, Jr.,	River Falls, Wis.	Mrs. Healy's.

NAME.	RESIDENCE.	ROOM.
Peacock, Dan,	Chicago, Ill.	Mrs. A. Harris's.
Randall, Huntley Burnham,	Detroit.	Keweenaw Club.
Rashleigh, William John,	Houghton.	Mrs. A. Burrows's.
Reynolds, Fred Llewellyn,	Pasadena, Cal.	Mrs. Healy's.
Richey, Appleton,	Houghton.	Mr. A. R. Richey's.
Roberts, Frederick Charles, S. B. (Northwestern University),	Crystal Falls.	Mrs. McAllister's.
Russell, Edward Francis,	Yonkers, N. Y.	Mr. C. Brand's.
Sarazin, William George,	Lake Linden.	Oriental House.
Schumann, Enrique Adolpho,	Santiago, Cuba.	Keweenaw Club.
Shields, James Wilson,	Hancock.	Mr. Jas. W. Shields's.
Slock, George,	Houghton.	Mr. Slock's.
Smith, Willard Joseph,	Allouez.	Miss Kelly's.
Snell, Henry Vincent,	Lake Linden.	Mrs. A. Burrows's.
Snow, Arthur Eugene,	St. George, Utah.	Mrs. West's.
Spaulding, Charles Frank,	Rogers Park, Ill.	Mrs. West's.
Strickland, Roland Hugh, C. E. (Royal Military College, Kingston, Ontario),	Lakefield, Ont.	Mrs. West's.

NAME.	RESIDENCE.	ROOM.
Sutton, William John,	Victoria, B. C.	Stroebel's Block.
Taylor, William Wisner, Jr.,	Grand Rapids.	Mr. C. Brand's.
Thomas, James Arthur,	Houghton.	Mr. W. H. Thomas's.
Trethewey, James Henry,	Lake Linden.	Mr. Trethewey's.
Truettner, Irving Willard,	Bessemer.	Mr. J. Thomas's.
Van Orden, Frank Lyon,	Houghton.	Mr. M. VanOrden's.
Walker, Elton Willard,	Detroit.	Mrs. West's.
Wearne, William, Jr.,	Red Jacket.	Mrs. A. Burrows's.
Works, Ralph Clark,	Lima, N. Y.	Stroebel's Block.
Wright, Frederick Bennett,	Oberlin, Ohio.	Douglass House.
Zertuche, Ygnacio Maria,	Monterey, Mex.	Mr. A. Haas's.

SUMMARY, 1894-1895.

Graduate Students	2
Class of 1895	25
Class of 1896	11
Class of 1897	16
Special Students	40
	94

BY COUNTRIES AND STATES.

Alabama	1
British Columbia	1
California	1
Ontario	5
Cuba	1
England	1
Illinois	1
Kansas	1
Mexico	3
Michigan, Upper Peninsula, 46 Lower Peninsula, 16	62
Minnesota	3
Mississippi	1
Montana	1
New Brunswick	1
New York	4
Pennsylvania	1
Texas	1
Utah	1
Virginia	1
Wisconsin	3
	94

SUMMARY, 1895–1896.

Number of Students Enrolled	94

BY COUNTRIES AND STATES.

Alabama	1
British Columbia	1
California	1
Ontario	5
Colorado	1
Cuba	1
Germany	2
Illinois	5
Indiana	1
Kansas	1
Massachusetts	1
Mexico	2
Michigan, { Upper Peninsula, 46 Lower Peninsula, 12 }	58
Montana	3
New York	5
Pennsylvania	1
Ohio	1
South Africa	1
Utah	1
Wisconsin	1
Wyoming	1
	94

AVERAGE AGE OF STUDENTS.

1894–1895.

Special Students	21 years.
Class of 1897	20 1-2 years.
Class of 1896	21 years.
Class of 1895	22 years.
Graduate Students	27 years.
Average Age of all Students	21 1-2 years.

1895–1896.

Average Age of Students	23 years.

OFFICERS OF THE ATHLETIC ASSOCIATION.

1894–1895.

President	Edward Russell.
Vice President	John Daniell.
Secretary	Frederick Walpole Hoar.
Treasurer	Camilo Figueroa.

1895–1896.

President	John Daniell.
First Vice President	Roland Hugh Strickland.
Second Vice President	Warren Downes Parker, Jr.
Secretary	Alonzo Webster Clark, Jr.
Treasurer	Dan Peacock.

ADVISORY COMMITTEE.

Dr. George Augustus Koenig.
Burton Tyndall Seeley, E. M.
George Henry Ronald Harris, C. E.

MICHIGAN MINING SCHOOL ALUMNI ASSOCIATION.

President	J. Fisher.
First Vice President	E. W. Walker.
Second Vice President	C. G. Mason.
	J. B. Esselstyn.
Director, One Year	J. B. Watson.
Director, Two Years	J. G. Kirchen.
Director, Three Years	W. J. Uren.

CALENDAR 1895-1896.

FALL TERM commences Friday morning, September 13, 1895.

Examinations for admission and advanced standing commence Friday morning at 9 o'clock, and continue through Friday and Saturday.

Regular work for all classes commences Monday, September 16, 1895, at 8 a. m., and all classes are expected to be fully prepared for work at that time.

Thanksgiving recess, November, Wednesday noon until Monday morning.

Fall term ends Friday evening, December 20, 1895.

WINTER TERM commences Monday morning, January 6, 1896, and ends Friday evening, April 10, 1896.

SUMMER TERM commences Monday morning, April 20, 1896, and ends Friday evening, August 14, 1896.

Practical Work in Mine Surveying and Mining begins Monday morning, April 20, and ends Friday evening, May 29, 1896.

Field Work in Surveying commences Monday morning, June 1, and ends Wednesday evening, August 12, 1896.

Shop Practice begins Monday morning, June 1, and ends Wednesday evening, August 12, 1896.

Practical Work in Ore Dressing and in Testing Materials of Engineering commence Monday morning, June 1, and end Friday evening, July 3, 1896.

Field Geology begins Monday morning, July 6, and ends Wednesday evening, August 12, 1896.

Commencement Exercises, Thursday and Friday, August 13 and 14, 1896.

Thursday—Field day, all classes, 9 A. M. and 2 P. M.

Reception for the Graduating Class, by the Undergraduates, 9 P. M.

Friday—Annual Meeting of the Board of Control, 10 A. M.
Graduation Exercises, 2 P. M.
Meeting of the Alumni Association, 4 P. M.
Alumni Dinner, 8:30 P. M.

CALENDAR, 1896–1897.

FALL TERM commences Friday morning, September 18, 1896, and ends Thursday noon, December 24, 1896.

Examinations for admission and advanced standing commence Friday at 9 A. M., and continue through Friday and Saturday.

Regular work for all classes commences Monday, September 21, 1896, at 8 A. M., and all students are expected to be fully prepared to take up their work at that time.

Thanksgiving recess, November, Wednesday noon until Monday morning.

WINTER TERM commences Monday morning, January, 11 and ends Friday noon, April 16, 1897.

SUMMER TERM commences Monday morning, April 26, 1897, and ends Friday evening, August 20, 1897.

Practical Work in Mine Surveying and Mining begins Monday morning, April 26, and ends Friday evening, June 4, 1897.

Surveying commences Monday morning, June 7, and ends Thursday evening, August 19, 1897.

Shop Practice begins Monday morning, June 7, and ends Thursday evening, August 19, 1897.

Ore Dressing and Testing Materials of Engineering commence Monday morning, June 7, and end Friday evening, July 9, 1897.

Field Geology begins Tuesday morning, July 12, and ends Thursday evening, August 19, 1897.

Commencement Exercises, Friday, August 20, 1897.

Friday—Field Day—All classes.
Annual Meeting of the Board of Control, 2:30 P. M.
Meeting of the Alumni Association, 5 P. M.
Alumni Dinner, 5:30 P. M.
Graduation Exercises, 8 P. M.
Reception for the Graduating Class by the Undergraduates, 10 P. M.

CALENDAR, 1897–1898.

FALL TERM commences Friday morning, September 17, 1897, ends Friday noon, December 24, 1897.

Examinations for admission and advanced standing commence Friday at 9 A. M., and continue through Friday and Saturday.

Regular work for all classes commences Monday, September 20, 1897, at 8 A. M. Full work is to be taken up at this time.

Thanksgiving recess, November, Wednesday noon until Monday morning.

WINTER TERM commences Monday morning, January 10, and ends Friday noon, April 15, 1898.

SUMMER TERM commences Monday morning, April 25, 1898, and ends Friday evening, August 19, 1898.

Practical Work in Mine Surveying and Mining commences Monday morning, April 25, and ends Friday evening, June 3, 1898.

Field Work in Surveying commences Monday morning, June 6, and ends Thursday evening, August 18, 1898.

Shop Practice begins Monday morning, June 6, and ends Thursday evening, August 18, 1898.

Ore Dressing and Testing Materials of Engineering commence Monday morning, June 6, and end Friday evening, July 8, 1898.

Field Geology begins Monday morning, July 11, and ends Thursday evening, August 18, 1895.

Commencement Exercises, Friday, August 19, 1898.

Friday—Field day, all classes.

Annual Meeting of the Board of Control, 2:30 P. M.
Meeting of the Alumni Association, 5 P. M.
Alumni Dinner, 5:30 P. M.
Graduation Exercises, 8 P. M.
Reception for the Graduating Class by the Undergraduates, 10 P. M.

CALENDAR 1898–1899.

FALL TERM commences Friday morning, September 16, 1898, ends Friday noon, December 23, 1898.

Examinations for admission and advanced standing commence

Friday morning at 9 o'clock, and continue through Friday and Saturday.

Regular work for all classes commences Monday, September 19, 1898 at 8 a. m. Full work is to be taken up at this time.

Thanksgiving recess, November, Wednesday noon until Monday morning

WINTER TERM commences Monday morning, January 9, and ends Friday noon, April 14, 1899.

SUMMER TERM commences Monday morning, April 24, 1899, and ends Friday evening, August 18, 1899.

Practical Work in Mine Surveying and Mining begins Monday morning, April 24, and ends Friday evening, June 2, 1899.

Surveying commences Monday morning, June 5, and ends Thursday evening, August 17, 1899.

Shop Practice begins Monday morning, June 5, and ends Thursday evening, August 17, 1899.

Ore Dressing and Testing Materials of Engineering commence Monday morning, June 5, and end Friday evening, July 7, 1899.

Field Geology begins Monday morning, July 10, and ends Thursday evening, August 17, 1899.

Commencement Exercises, Friday August 18, 1899.

Thursday—Field day, all classes, 9 A. M. and 2 P. M.

Friday—Annual Meeting of the Board of Control, 2:30 P. M.
Meeting of the Alumni Association, 5 P. M.
Alumni Dinner, 5:30 P. M.
Graduation Exercises, 2:30 P. M.
Reception for the Graduating Class, by the Undergraduates, 10 P. M.

CALENDAR, 1896.

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CALENDAR, 1897.

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CALENDAR, 1898.

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CALENDAR, 1899.

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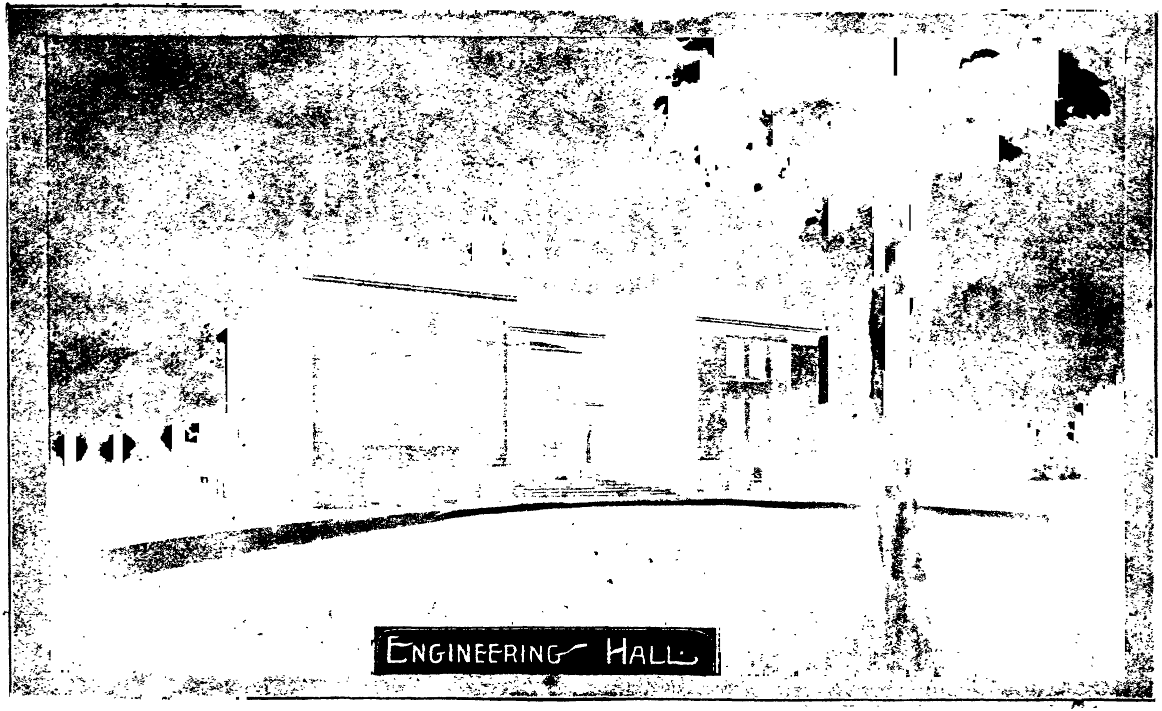

ENGINEERING HALL